Open Lake Disposal (Sediment and Water Quality Evaluation)

APPENDIX B3
SEDIMENT SAMPLING
AND LABORATORY RESULTS

. .

Sediment and Water Quality Evaluation of the Toledo Harbor Sediments

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to evaluate the quality of the Toledo Harbor sediments and to determine their suitability for open lake disposal. This assessment was performed by comparing the chemical and biological characteristics against evaluation criteria previously developed by Ohio EPA and USEPA and USACE.

1.2 Sampling & Testing

The Toledo Harbor sediment and water testing results are found in REPORT FOR SEDIMENT & WATER SAMPLING AND CHEMICAL ANALYSIS AT TOLEDO, OHIO HARBOR – TECHNICAL REPORT VOLUME I, January, 2000 Contract No. DACW49-97-D-0006 Delivery Order No. 0018, PADIA Environmental Inc. Detailed laboratory reports are found in Volume II. The biological reports can be referenced in Volume II or RESULTS OF DAPHNIA MAGNA, PPIMEPHALES PROMELAS, CHIRONOMUS TENTANS, HYALELLA AZTECA, AND LUMBRICULUS VARIEGATUS TOXICITY TESTS ON 12 SEDIMENTS FROM TOLEDO HARBORCOLLECTED MAY 26 & 27, 1999 and RESULTS OF THE LUMBRICULUS VARIEGATUS 28-DAY CHEMICAL ACCUMULATION TEST by Aqua Tech Environmental Laboratories.

The sediments were tested for five different categories of chemical parameters – metals, PAHs, Pesticides & PCBs, and miscellaneous inorganics. The Metals consist of the USEPA Target Analyte List of metals which includes: aluminum, antimony, arsenic, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. The PAH group includes: 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. The list of pesticides consists of: 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, alpha-BHC, beta-BHC, chlordane, delta-BHC, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, lindane heptachlor, heptachlor epoxide, methoxychlor, and toxaphene. PCBs are measured as aroclors and include aroclor 1016, aroclor 1221, aroclor 1232, aroclor 1242, aroclor 1248, aroclor 1254, and aroclor 1260. The miscellaneous inorganics include: total organic carbon, chemical oxygen demand, total Kjeldahl nitrogen (TKN), ammonia, nitrite & nitrate, cyanide, oil & grease, and total phosphorus.

The elutriate waters were tested for the same parameters as the sediments.

Biological testing included water column toxicity testing, sediment toxicity testing, and sediment bioaccumulation. The water column toxicity testing measured mortality for *Daphnia magna* and *Pimephales promelas* for dilutions of elutriate disposal waters. Solid phase sediment toxicity testing measured mortality for *Hyalella azteca* and *Chironomus tentans* and growth for *Chironomus tentans*. The bioaccumulation testing used the organism *Lumbriculus variegatus* for determining potential bioaccumulation of the metals, PAHs, pesticides, and PCBs measured for the sediments.

Disposal site waters were tested for the same parameters as the sediments plus dissolved oxygen, temperature, and pH.

1.3 Selection of Evaluation Areas

The Toledo Harbor channel sediments are divided into seven reaches for evaluation purposes. These are the Maumee River, the river mouth area, the channel from LM-1 to LM-2, the channel from LM-2 to LM-5, the channel from LM-5 to LM-7, the channel from LM-1 to LM-11, and the channel from LM11 to LM-16.

The Toledo Metro Sewage Treatment Plant outfall is located at the mouth of the Maumee River. Historically in the past, all dredged sediments from the river channel and lake channel out to LM-2 have been placed in the Toledo (CDF) confined disposal facility. The cutoff at LM-2 has recently been extended to LM-5. Presently, all dredged sediments from the Maumee River and lake entrance channel out to LM-5 are confined in the Toledo CDF. The lake channel from LM-11 to LM-16 is rarely dredged. Therefore, the river, river mouth area to LM-2, and the reach from LM-2 to LM-5 were separately tested. The dredged lake channel from LM-5 to LM-11 is divided into two reaches, LM-5 to LM-7 and LM-7 to LM-11

Latitude and longitude of the sample sites is given in Table 1.3 at the end of the report.

2.0 SEDIMENT EVALUATION

The only existing dredged sediment evaluation criteria are presented in the Great Lakes Dredged Material Testing and Evaluation Manual, 1997. The guidance provided in this manual indicate the chemical contamination level of the sediments be compared to those found in the reference sediments. Judgement must be used in the comparison process. There are no definitions of "similar", "comparable", "comparable", "higher", and "elevated". The bioassay testing uses statistics and the evaluation process is well defined. Samples are tested for statistically significant differences in mortality and average bioaccumulation chemistry when values are greater than 20 percent. The analytical results for each sediment sample are shown at the end of this report. Table 1 shows all of the results for the metals. Table 2 shows all of the results for the PAHs. Table 3 shows the pesticides and PCBs. Table 4 shows the results for the miscellaneous inorganic parameters. For all of the tables in this report, in some cases, there are values that are less than the reporting limits. The laboratory defines these values as "J" values. These "J" values are actual measured values that are present in the sample however they are estimated quantities. "U" values indicate non-detectable values at the reporting limits.

When referencing the bioaccumulation report, in some cases some of the measured tissue concentrations are reported with the "J" and are higher than other replicate values at the same site or another site. This is because the detection limits depend upon the sample size, that is, the amount of worm tissue that could be harvested for each replicate.

2.1 Reference Sediment Evaluation Criteria

Because there are no existing analytically defined evaluation criteria, the maximum measured reference value will be used. See Figure 2.1 for the open-lake reference area location and the reference sample site locations.

In some cases, there are non-detectable values represented by "<" with a reporting limit. This means if there is a concentration for the parameter, it is less than the reporting limit and is unknown. For the reference area there may be a range given by less than values. This reflects values adjusted for moisture content. In such cases, the highest value magnitude was used as the evaluation criteria. In some cases a "J" value was identified and the value treated as a detected value and used as such. The "J" value is an estimated value below the reporting limit. This value would override the less than values.

Tables 5-8 indicate the contaminant magnitude levels above the reference as defined below for metals, PAHs, pesticides and PCBs, and miscellaneous inorganic parameters, respectively. These tables are attached at the end of the report.

Theoretically, the reference sediment evaluation criteria should represent the sediments of the whole western basin of Lake Erie. Since the evaluation criteria are based on the reference area which is a small subset of the western basin, caution must be used when interpreting the sediment evaluation results.

2.1.1 Metals Evaluation Criteria

The sediment metals evaluation criteria using the maximum measured open-lake reference area values are given below in Table 2.1.1 for each of the metals of interest.

Table 2.1.1 Metals Evaluation Criteria

		Evaluation
	Range	Value
Antimony	0.02 to 0.1 mg/kg	0.10 mg/kg
Arsenic	2.1 to 2.9 mg/kg	2.9 mg/kg
Barium	36 to 53 mg/kg	53 mg/kg
Beryllium	0.1 to 0.4 mg/kg	0.4 mg/kg
Cadmium	0.6 to 1.5 mg/kg	1.5 mg/kg
Chromium	4.6 to 17 mg/kg	17 mg/kg
Cobalt	1.8 to 6.2 mg/kg	6.2 mg/kg
Copper	6.3 to 22 mg/kg	22 mg/kg
Lead	4.6 to 19 mg/kg	19 mg/kg
Mercury	0.06 to 0.22 mg/kg	0.22 mg/kg
Nickel	5.4 to 19 mg/kg	19 mg/kg
Selenium	<0.33 to <0.44 mg/kg	<0.44 mg/kg
Silver	0.2 to 0.5 mg/kg	0.5 mg/kg
Thallium	0.1 to 0.2 mg/kg	0.2 mg/kg
Vanadium	3.8 to 12 mg/kg	12 mg/kg
Zinc	24 to 78 mg/kg	78 mg/kg

2.1.2 Sediment PAH Evaluation Criteria

The sediment PAHs evaluation criteria using the maximum measured open-lake reference area values are given below in Table 2.1.2 for each of the PAHs.

Table 2.1.2 PAH Evaluation Criteria

	Panga	Evaluation
0.36-41-3	Range	Value
2-Methylnaphthalene	<0.95 to < 1.08 mg/kg	<1.08 mg/kg
Acenaphthene	<0.45 to <0.54 mg/kg	<0.54 mg/kg
Acenaphthylene	<0.48 to <0.54 mg/kg	<0.54 mg/kg
Anthracene	<0.38 to <0.43 mg/kg	<0.43 mg/kg
Benzo(a)anthracene	<0.48 to <0.54 mg/kg	<0.54mg/kg
Benzo(a)pyrene	<0.51 to 0.10 mg/kg	0.10 mg/kg
Benzo(b)fluoranthene	<0.54 to 0.14 mg/kg	0.14 mg/kg
Benzo(ghi)perylene	<0.57 to <0.65 mg/kg	<0.65 mg/kg
Benzo(k)fluoranthene	<0.72 to 0.11 mg/kg	0.11 mg/kg
Chrysene	<0.51 to 0.12 mg/kg	0.12 mg/kg
Dibenzo(a,h) anthracene	<0.48 to <0.54 mg/kg	<0.54 mg/kg
Dibenzofuran	<0.48 to <0.54 mg/kg	<0.54 mg/kg
Fluoranthene	<0.51 to 0.13 mg/kg	0.13 mg/kg
Fluorene	<0.48 to <0.54 mg/kg	<0.54mg/kg
Indeno(1,2,3-cd)pyrene	<0.48 to <0.54 mg/kg	<0.54 mg/kg
Naphthalene	<0.48 to <0.54 mg/kg	<0.54 mg/kg
Phenanthrene	<0.38 to <0.43 mg/kg	<0.43 mg/kg
Pyrene	<0.41 to 0.13 mg/kg	0.13 mg/kg
Total PAH	0 to 0.73 mg/kg	0.73 mg/kg

2.1.3 Sediment Pesticides and PCBs Evaluation Criteria

The sediment pesticides and PCBs evaluation criteria using the maximum measured open-lake reference area values are given below in Table 2.1.3 for each of the PCBs and pesticides.

Table 2.1.3 PCB & Pesticide Evaluation Criteria

	Range	Evaluation Value
Aroclor 1016	<0.19 to <0.22 mg/kg	<0.22 mg/kg
Aroclor 1221	<0.19 to <0.22 mg/kg	<0.22 mg/kg
Aroclor 1232	<0.19 to <0.22 mg/kg	<0.22mg/kg

<0.19 to <0.22 mg/kg	<0.22 mg/kg
<0.19 to <0.22 mg/kg	<0.22 mg/kg
0.02 to 0.06 mg/kg	0.06mg/kg
<0.19 to <0.22 mg/kg	<0.22 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<0.57 to <0.65 mg/kg	<0.65 mg/kg
<0.57 to <0.65 mg/kg	<0.65 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<1.9 to <2.2 mg/kg	<2,2 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<0.57 to <0.65 mg/kg	<0.65 mg/kg
<0.57 to <0.65 mg/kg	<0.65 mg/kg
<0.57 to <0.65 mg/kg	<0.65mg/kg
<0.95 to <1.1 mg/kg	<1.1 mg/kg
<0.95 to <1.1 mg/kg	<1.1 mg/kg
<0.38 to <0.43 mg/kg	<0.43 mg/kg
<0.57 to <0.65 mg/kg	<0.65mg/kg
<0.57 to <0.65 mg/kg	<0.65 mg/kg
<0.57 to <0.65 mg/kg	<0.65 mg/kg
<1.9 to <2.2mg/kg	<2.2 mg/kg
	 <0.19 to <0.22 mg/kg 0.02 to 0.06 mg/kg <0.19 to <0.22 mg/kg <0.19 to <0.22 mg/kg <0.57 to <0.65 mg/kg <0.57 to <0.65 mg/kg <0.38 to <0.43 mg/kg <0.57 to <0.65 mg/kg

2.1.4 Miscellaneous Inorganic Parameter Evaluation

The sediment miscellaneous inorganic parameter evaluation criteria using the maximum measured openlake reference area values are given below in Table 2.1.4 for each of the individual parameters.

Table 2.1.4 Misc Parameter Evaluation Criteria

_	Range	Evaluation Value
COD	33500 to 52000 mg/kg	52000 mg/kg
Cyanide	<0.30 to 0.66 mg/kg	0.66 mg/kg
Ammonia	26 to 207 mg/kg	207 mg/kg
Nitrite + Nitrate	<0.33 to 0.4 mg/kg	0.4 mg/kg
TKN	866 to 1700 mg/kg	1700 mg/kg
Oil & Grease	207 to 288 mg/kg	288 mg/kg
Total Phosphorus	320 to 600 mg/kg	600 mg/kg

2.2 Sediment Elutriate Water Evaluation Criteria

The evaluation criteria for the sediment elutriate water is based on the 1997 Ohio EPA water quality standards. This evaluation criteria is provided in Section 3.1

2.3 Biological Evaluation Criteria

The biological toxicity and bioaccumulation testing and evaluation are based on the testing protocols presented in the *Great Lakes Dredged Material Testing and Evaluation Manual*, 1997. Samples that have a mortality/growth/chemistry greater than 20 percent of the reference value are tested for statistically significant differences. The biological testing areas are shown in Figure 2.3.

2.4 Maumee River Federal Navigation Channel Evaluation

This area consists of the federally maintained navigation channel from RM-7 to RM-1 and includes sampling sites RM-7, RM-6, RM-5, RM-4, RM-3, RM-2, RM-1 (see Figure 2.4).

2.4.1 Metals Evaluation

Table 2.4.1 shows the magnitude above the reference sediments for metals for areas RM-7, RM-6, RM-5, RM-4, RM-3, RM-2 and RM-1. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.4.1 Metals Evaluation

	RM-7	RM-6	RM-5	RM-4	RM-3	RM-2	RM-1
Antimony	2.00	2.00	2.00	2.00	2.00	2.00	3.00
Arsenic	1.65	1.24	1.55	2.07	1.55	1.59	1.83
Barium	1.25	1.66	1.62	1.62	1.77	1.89	1.53
Beryllium	1.25	1.50	1.50	1.50	1.75	2.00	1.25
Cadmium							
Chromium				1.12		1.12	1.53
Cobalt	1.15	1.37	1.37	1.29	1.50	1.55	1.23
Copper		1.23	1.09	1.41	1.18	1.32	1.50
Lead	1.11			1.37			1.16
Mercury							
Nickel		1.11	1.16	1.21	1.26	1.31	1.37
Selenium							
Silver		1.60		2.60	7.80	2.20	4.00
Thallium		1.50		1.50	1.50	1.50	1.50
Vanadium	1.25	1.50	1.25	1.50	1.67	1.83	1.33
Zinc		1.16		1.28	1.19	1.23	2.05

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.4.2 PAH Evaluation

Table 2.4.2 shows the magnitude above the reference sediments for PAHs for those areas where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.4.2 PAH Evaluation

	RM-7	RM-6	RM-5	RM-4	RM-3	RM-2	RM-1
2-Methylnaphthalene							-
Acenaphthene							
Acenaphthylene							
Anthracene							<u> </u>
Benzo(a)anthracene				i			l
Benzo(a)pyrene				1.60			1.60
Benzo(b)fluoranthene				1.57			1.07
Benzo(ghi)perylene				1.07		-	1.07
Benzo(k)fluoranthene							
Chrysene				1.42	_		1.33
Dibenzo(a,h) anthracene		_					
Dibenzofuran							
Fluoranthene				1.77		1.23	1.38
Fluorene						7.25	1.00
Indeno(1,2,3-cd)pyrene							
Naphthalene							-
Phenanthrene							
Pyrene				1.69		1.08	1.46
Total PAH				1.57		2.50	1.63

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.4.3 Pesticide & PCB Evaluation

Table 2.4.3 A shows the magnitude above the reference sediments for PCB where exceedance occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.4.3 A PCB Evaluation

	RM-7	RM-6	RM-5	RM-4	RM-3	RM-2	RM-1
Aroclor 1016							
Aroclor 1221							
Aroclor 1232							
Aroclor 1242							
Aroclor 1248	<u> </u>						
Aroclor 1254	9.33		İ	2.17			
Aroclor 1260							

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of the pesticide evaluation criteria. This is reflected in Table 2.4.3 B. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.4.3 B Pesticide Evaluation

-	RM-7	RM-6	RM-5	RM-4	RM-3	RM-2	RM-1
4,4'-DDD							
4,4'-DDE							
4,4'-DDT							
Aldrin							
Alpha-BHC							
Beta- BHC			<u> </u>				
Chlordane							
Delta-BHC							
Dieldrin							
Endosulfan I							
Endosulfan II							
Endosulfan sulfate							
Endrin					·		
Endrin aldehyde							
Lindane							
Heptachlor				1			
Heptachlor epoxide							-
Methoxychlor							
Toxaphene				ĺ		<u> </u>	

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.4.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.4.4 shows the magnitude above the reference sediments for the miscellaneous parameters where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.4.4 Misc Parameter Evaluation

	RM-7	RM-6	RM-5	RM-4	RM-3	RM-2	RM-1
COD		1.04	1.45		1.16	1.04	1.79
Cyanide						1.82	
Ammonia							1.68
Nitrite + Nitrate	5.00	5.00	10.0	5.00	5.00	5.00	5.00
TKN							
Oil & Grease	1.46	1.53	2.53	3.82	1.42	1.22	3.82
Total Phosphorus	1.03	1.19	1.08	1.22	1.23	1.32	2.40

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.4.5 Biological Evaluation

For this area sediments from RM-1 were combined with sediments from RM-0.5 and LM-0 for biological testing. Material from this area is confined in the Toledo CDF and biological data was deemed not necessary.

2.4.5.1 Sediment Water Column Elutriate Acute Toxicity Evaluation

Biological testing was not conducted on the river area. Material from this area is confined in the Toledo CDF and biological data was deemed not necessary.

2.4.5.2 Sediment Solid Phase Toxicity Evaluation

Biological testing was not conducted for the river area. Material from this area is confined in the Toledo CDF and biological data was deemed not necessary.

2.4.5.3 Sediment Solid Phase Bioaccumulation

Biological testing was not conducted on the river area. Material from this area is confined in the Toledo CDF and biological data was deemed not necessary.

2.5 Maumee River Mouth Area Federal Navigation Channel Evaluation

This area consists of the federally maintained navigation channel from RM-1 to LM-1 and includes sampling sites RM-0.5, LM-0, LM-0.5 (see Figure 2.5).

2.5.1 Metals Evaluation

Table 2.5.1 shows the magnitude above the reference sediments for the areas RM-0.5, LM-0 and LM-0.5. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.5.1 Metals Evaluation

L	RM-0.5	LM-0	LM-0.5
Antimony	5.00	3.00	
Arsenic	1.28	1.79	1.45
Barium		1.75	1.47
Beryllium		1.75	1.50
Cadmium			
Chromium	1.18		
Cobalt		1.47	1.27

Copper	2.55	1.18	
Lead	1.58		
Mercury	1.73		
Nickel	1.21	1.21	
Selenium	1.14		
Silver	2.86	1.71	1.71
Thallium		1.50	
Vanadium		1.75	1.42
Zinc	1.41	1.10	

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.5.2 PAH Evaluation

Table 2.5.2 shows the magnitude above the reference sediments for PAHs where exceedances occurred. . A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.5.2 PAH Evaluation

	RM-0.5	LM-0	LM-0.5
2-Methylnaphthalene			i
Acenaphthene			
Acenaphthylene	1		
Anthracene			
Benzo(a)anthracene			
Benzo(a)pyrene	2.50		
Benzo(b)fluoranthene	4.71		
Benzo(ghi)perylene			
Benzo(k)fluoranthene	3.36		
Chrysene	4.08		
Dibenzo(a,h) anthracene			
Dibenzofuran			
Fluoranthene	4.23	1.23	
Fluorene			1
Indeno(1,2,3-cd)pyrene			
Naphthalene			
Phenanthrene		j	
Pyrene	2.54		
Total PAH	2.95	·	† · · · · · · · · · · · · · · · · · · ·

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.5.3 Pesticide & PCB Evaluation

There is no exceedance of pesticide evaluation criteria. Table 2.5.3 A shows no PCB values above the reference sediments for PCBs. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.5.3 A PCB Evaluation

	RM-0.5	LM-0	LM-0.5
Aroclor 1016			
Aroclor 1221			
Aroclor 1232			
Aroclor 1242			
Aroclor 1248			
Aroclor 1254			
Aroclor 1260			

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of pesticide evaluation criteria as reflected in Table 2.5.3 B.. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.5.3 B Pesticide Evaluation

	RM-0.5	LM-0	LM-0.5
4,4'-DDD			
4,4'-DDE			
4,4'-DDT			
Aldrin			
Alpha-BHC			
Beta- BHC			
Chlordane			
Delta-BHC			
Dieldrin			
Endosulfan I			
Endosulfan II			
Endosulfan sulfate			
Endrin			
Endrin aldehyde			
Lindane			
Heptachlor			
Heptachlor epoxide			
Methoxychlor			
Toxaphene			

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.5.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.5.4 shows the magnitude above the reference sediments for the miscellaneous inorganic parameters where the exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.5.4 Misc Parameter Evaluation

	RM-0.5	LM-0	LM-0.5
COD		2.21	1.94
Cyanide		1.45	
Ammonia			1.51
Nitrite + Nitrate	2.50	5.00	5.00
TKN		1,53	
Oil & Grease	29.5	1.63	1.08
Total Phosphorus	5.92	1.14	

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.5.5 Biological Evaluation

Sediments for this area were tested using sediments from RM-1, RM-0.5, and LM-0 as a sediment management unit (labeled as MA-1 in the chemistry reports and B-1 in the biological reports) and sediments from LM-0, LM-0.5, and LM-1 as a sediment management unit (labeled as MA-2 in the chemistry reports and B-2 in the biological reports). See Figure 2.3. These management units were tested for *Hyalella azteca* toxicity and *Chironomus tentans* toxicity and growth. Sediments were also tested for bioaccumulation of metals, PAHs, PCBs, and pesticides using *Lumbriculus variegatus*.

2.5.5.1 Sediment Water Column Elutriate Acute Toxicity Evaluation

The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water was not acutely toxic to the daphnia or minnows so a LC₅₀ could not be determined for these sediments.

2.5.5.2 Sediment Solid Phase Toxicity Evaluation

The sediments for this reach were found to be compatible with the open-lake sediments. There was a *Chironomus tentans* growth problem with the sediments from the first management area.

2.5.5.3 Sediment Solid Phase Bioaccumulation

No measurable bioaccumulation of PAHs, pesticides, and PCBs was measured. Organic levels detected in the bioassay sediments were very low.

Bioaccumulation of some metals did occur for the two sediment bioaccumulation management areas. For the first sediment management area, sediment metals barium, chromium, and copper were found to bioaccumulate at levels significantly greater than the corresponding metals in test organisms exposed to the open-lake reference sediments. From the second area, arsenic bioaccumulation levels were statistically significantly different from the reference sediments. Therefore, with respect to this reach, the dredged sediment metal levels for arsenic, barium, chromium, and copper are not similar with reference sediments.

The bioaccumulation levels for the metals may be artificially high because of the replicate average which used the high value for the non-detected values. This approach gave a conservative evaluation.

2.6 Lake Entrance Federal Navigation Channel Lake Mile 2 Inward to River Mouth Area Evaluation

This area consists of the federally maintained navigation channel from LM-1 to LM-2 and includes sampling sites LM-1, LM-1.5, LM-2 (see Figure 2.6).

2.6.1 Metals Evaluation

Table 2.6.1 shows the magnitude above the reference sediments for metals for areas LM-1, LM-1.5 and LM-2. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.6.1 Metal Evaluation

	LM-1	LM-1.5	LM-2
Antimony	2.00	2.00	3.00
Arsenic	1.76	2.00	1.59
Barium	1.40	1.57	1.89
Beryllium	1.50	1.50	2.00
Cadmium			
Chromium			1.12
Cobalt	1.23	1.34	1.61
Copper	1.09	1.09	1.36
Lead			
Mercury			
Nickel	1.11	1.16	1.37
Selenium			
Silver	1.43		
Thallium	1.50	1.50	1.50
Vanadium	1.33	1.58	1.92
Zinc	1.13	1.05	1.28

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.6.2 PAH Evaluation

Table 2.6.2 shows the magnitude above the reference sediments for PAHs in area where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.6.2 PAH Evaluation

	LM-1	LM-1.5	LM-2
2-Methylnaphthalene			
Acenaphthene			
Acenaphthylene			
Anthracene			
Benzo(a)anthracene			
Benzo(a)pyrene			-
Benzo(b)fluoranthene			
Benzo(ghi)perylene			
Benzo(k)fluoranthene			
Chrysene			
Dibenzo(a,h) anthracene			
Dibenzofuran			
Fluoranthene		1.08	
Fluorene			
Indeno(1,2,3-cd)pyrene			
Naphthalene			
Phenanthrene			
Pyrene			
Total PAH			

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.6.3 Pesticide & PCB Evaluation

There is no exceedance for the PCB criteria as shown in Table 2.6.3 A. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.6.3 A PCB Evaluation

	LM-1	LM-1.5	LM-2
Aroclor 1016			
Aroclor 1221			
Aroclor 1232		ļ ———	
Aroclor 1242			
Aroclor 1248			
Aroclor 1254			
Aroclor 1260	<u> </u>		

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of pesticide evaluation criteria shown in Table 2.6.3 B. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.6.3 B Pesticide Evaluation

	LM-1	LM-1.5	LM-2
4,4'-DDD			
4,4'-DDE			
4,4'-DDT	<u> </u>		
Aldrin			
Alpha-BHC			
Beta- BHC			
Chlordane			***************************************
Delta-BHC			
Dieldrin			
Endosulfan I			
Endosulfan II			
Endosulfan sulfate			
Endrin			
Endrin aldehyde			
Lindane			
Heptachlor			
Heptachlor epoxide			
Methoxychlor			
Toxaphene			

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.6.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.6.4 shows the magnitude above the reference sediments for the miscellaneous parameters in areas where exceedances occurred.. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.6.4 Misc Parameter Evaluation

	LM-1	LM-1.5	LM-2
COD	1.53	1.56	1.35
Cyanide		3.48	
Ammonia			
Nitrite + Nitrate	2.50	5.00	5.00
TKN		1.44	1.54
Oil & Grease		1.48	2.54
Total Phosphorus		1.15	1.45

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.6.5 Biological Evaluation

Sediments for this area were tested using sediments from LM-1, LM-1.5, and LM-2 as a sediment management unit (labeled as MA-3 in the chemistry reports and as B-3 in the biological reports). See Figure 2.3. This management unit was tested for *Hyalella azteca* toxicity and *Chironomus tentans* toxicity and growth. Sediments were also tested for bioaccumulation of metals, PAHs, PCBs, and pesticides using *Lumbriculus variegatus*.

2.6.5.1 Sediment Water Column Elutriate Acute Toxicity Evaluation

The water column evaluation is based on elutriate water from the sediments using Daphnia magna and Pimephales promelas (minnows) as test organisms. Dilutions on the elutriate water were make to determine the dilution needed for 50 per cent survival. The full strength elutriate water was not acutely toxic to the daphnia or minnows so a LC_{50} could not be determined for these sediments. Initial screening indicated toxicity, but subsequent testing could not determine a LC_{50} . The laboratory attributed this to possible ammonia toxicity.

2.6.5.2 Sediment Solid Phase Toxicity Evaluation

The sediment management unit Hyalella azteca toxicity was found to be statistically significantly different from the open-lake reference sediments. These sediments are not suitable for open-lake disposal by the Great Lakes Testing Manual. The sediment management unit Chironomus tentans toxicity and growth was found to be similar to that of the open-lake sediments.

2.6.5.3 Sediment Solid Phase Bioaccumulation

No measurable bioaccumulation of PAHs, pesticides, and PCBs was measured. Organic levels detected in the bioassay sediments were very low, either close to or less than the detection limit.

Bioaccumulation of some metals occurred for this sediment bioaccumulation management area. For this reach, sediment metals arsenic, chromium, lead, and mercury were found to bioaccumulate at levels having a statistically significantly difference than the corresponding metals from the open-lake reference sediments.

The bioaccumulation levels for the metals may be artificially high because of the replicate average which used the high value for the non-detected values. This approach gave a conservative evaluation.

2.7 Lake Entrance Federal Navigation Channel Lake Mile 2 to Lake Mile 5 Evaluation This area consists of the federally maintained navigation channel from LM-2 to LM-5 and includes sampling sites LM-2.5, LM-3, LM-3, LM-4, LM-4.5 (see Figure 2.7).

2.7.1 Metals Evaluation

Table 2.7.1 shows the magnitude above the reference sediments for the metals from areas LM-2.5, LM-3, LM-3.5, LM-4, and LM-4.5. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.7.1 Metals Evaluation

	LM-2.5	LM-3	LM-3.5	LM-4	LM-4.5
Antimony	2.00	3.00	3.00	3.00	4.00
Arsenic	1.69	1.90	1.79	1.17	1.31
Barium	1.47	1.70	1.66	1.62	1.58
Beryllium	1.50	1.75	1.75	1.75	1.50
Cadmium					
Chromium					
Cobalt	1.44	1.53	1.56	1.45	1.44
Copper	1.23	1.36	1.32	1.23	1.18
Lead					
Mercury			1.50		
Nickel	1.21	1.26	1.32	1.21	1.21
Selenium					
Silver				1.71	
Thallium			1.50	1.50	1.50
Vanadium	1.58		1.75	1.50	1.58
Zinc		1.11	1.08	1.03	1.01

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.7.2 PAH Evaluation

Table 2.7.2 shows the magnitude above the reference sediment for PAHs where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.7.2 PAH Evaluation

	LM-2.5	LM-3	LM-3.5	LM-4	LM-4.5
2-Methylnaphthalene					
Acenaphthene					
Acenaphthylene					
Anthracene					
Benzo(a)anthracene					
Benzo(a)pyrene					
Benzo(b)fluoranthene					
Benzo(ghi)perylene					
Benzo(k)fluoranthene				<u> </u>	
Chrysene					
Dibenzo(a,h) anthracene					
Dibenzofuran				i	
Fluoranthene	1.23			i	
Fluorene					
Indeno(1,2,3-cd)pyrene					i

Naphthalene			I	
Phenanthrene				
Pyrene	1.15		_	
Total PAH			<u> </u>	

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.7.3 Pesticide & PCB Evaluation

There is no exceedance for the PCB criteria for this reach as reflected below. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.7.3 A PCB Evaluation

	LM-2.5	LM-3	LM-3.5	LM-4	LM-4.5
Aroclor 1016				1	
Aroclor 1221				<u> </u>	
Aroclor 1232					
Aroclor 1242					
Aroclor 1248					<u></u>
Aroclor 1254					
Aroclor 1260					

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of pesticide evaluation criteria. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.7.3 B Pesticide Evaluation

	LM-2.5	LM-3	LM-3.5	LM-4	LM-4.5
4,4'-DDD				1	
4,4'-DDE					
4,4'-DDT					
Aldrin					
Alpha-BHC					
Beta- BHC					
Chlordane					
Delta-BHC					
Dieldrin					
Endosulfan I					
Endosulfan II					
Endosulfan sulfate					
Endrin					
Endrin aldehyde					
Lindane					
Heptachlor		-			
Heptachlor epoxide		-			
Methoxychlor					
Toxaphene					

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.7.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.7.4 shows the magnitude above the reference sediment for the miscellaneous inorganic parameters where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.7.4 Misc Parameter Evaluation

	LM-2.5	LM-3	LM-3.5	LM-4	LM-4.5
COD	1.68	1.45	1.85	1.27	1.51
Cyanide				1.12	
Ammonia					
Nitrite + Nitrate		11.75			
TKN	1.60	1.35	1.61	1.64	1.54
Oil & Grease	1.02	2.31	2.43	1.34	
Total Phosphorus	1.17	1.50	1.33	1.13	1.12

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.7.5 Biological Evaluation

This area is represented by three sediment management units - [LM-2, LM-2.5, LM-3] (labeled as MA-4 in the chemistry reports and as B-4 in the biological reports), [LM-3, LM-3.5, LM-4] (labeled as MA-5 in the chemistry reports and as B-5 in the biological reports), and [LM-4, LM-4.5, LM-5] (labeled as MA-6 in the chemistry reports and as B-6 in the biological reports). See Figure 2.3. The two end points LM-2 and LM-5 are evaluated chemically in other channel areas.

2.7.5.1 Sediment Water Column Elutriate Acute Toxicity Evaluation

The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect to the daphnia or minnows.

2.7.5.2 Sediment Solid Phase Toxicity Evaluation

The sediments for this channel area were found to be of similar quality to the open-lake sediments.

2.7.5.3 Sediment Solid Phase Bioaccumulation

No measurable bioaccumulation of PAHs, pesticides, and PCBs was measured. Organic levels detected in the bioassay sediments were very low.

Bioaccumulation of some metals did occur for the three sediment bioaccumulation management areas. For the first sediment management area, no sediment metals were found to bioaccumulate at levels significantly greater than the corresponding metals from the open-lake reference sediments. From the second area, arsenic and mercury bioaccumulated at levels that were statistically significantly different from the reference sediments. For the third area, arsenic and lead bioaccumulated at significantly higher levels. Therefore, with respect to this reach, the dredged sediment metal levels for arsenic, lead, and mercury are not compatible with reference sediments.

The bioaccumulation levels for the metals may be artificially high because of the replicate average which used the high value for the non-detected values. This approach gave a conservative evaluation.

2.8 Lake Entrance Federal Navigation Channel Lake Mile 5 to Lake Mile 7 Evaluation This area consists of the federally maintained navigation channel from LM-5 to LM-7 and includes sampling sites LM-5, LM-5.5, LM-6, LM-6.5, LM-7 (see Figure 2.8).

2.8.1 Metals Evaluation

Table 2.8.1 shows the magnitude above the sediment reference sites for metals for areas LM-5, LM-5.5, LM-6, LM-6.5, and LM-7. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.8.1 Metals Evaluation

	LM-5	LM-5.5	LM-6	LM-6.5	LM-7
Antimony	3.00	2.00	2.00		2.00
Arsenic	1.34				
Barium	1.62	1.79	1.68	1.47	1.64
Beryllium	1.50	1.75	1.75	1.50	1.75
Cadmium	-				
Chromium					1.12
Cobalt	1.42	1.50	1.40	1.31	1.45
Copper	1.23	1.32	1.23	1.23	1.36
Lead					1.16
Mercury					
Nickel	1.21	1.26	1.26	1.16	1.32
Selenium					1.14
Silver		2.00	1.57	1.43	1.71
Thallium					
Vanadium	1.58	1.58	1.50	1.33	1.50
Zinc	1.10	1.19	1.17	1.08	1.22

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.8.2 PAH Evaluation

Table 2.8.2 shows the magnitude above the reference sediment sites for PAHs for the areas where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.8.2 PAH Evaluation

	LM-5	LM-5.5	LM-6	LM-6.5	LM-7
2-Methylnaphthalene					
Acenaphthene					
Acenaphthylene					
Anthracene					
Benzo(a)anthracene				·	
Benzo(a)pyrene		1.20			
Benzo(b)fluoranthene	_				1.07
Benzo(ghi)perylene					
Benzo(k)fluoranthene					
Chrysene					
Dibenzo(a,h) anthracene					
Dibenzofuran					
Fluoranthene					1.08

Fluorene		
Indeno(1,2,3-cd)pyrene		
Naphthalene		
Phenanthrene		
Pyrene	1.15	1.15
Total PAH		

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.8.3 Pesticide & PCB Evaluation

There is no exceedance for PCB criteria as reflected below. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.8.3 A PCB Evaluation

	LM-5	LM-5.5	LM-6	LM-6.5	LM-7
Aroclor 1016					
Aroclor 1221					
Aroclor 1232					
Aroclor 1242					
Aroclor 1248	l				
Aroclor 1254					
Aroclor 1260	1				

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of pesticide evaluation criteria as shown in Table 2.8.3 B. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.8.3 B Pesticide Evaluation

	LM-5	LM-5.5	LM-6	LM-6.5	LM-7
4,4'-DDD					
4,4'-DDE			·		
4,4'-DDT					
Aldrin					
Alpha-BHC	-				
Beta- BHC					
Chlordane					

Delta-BHC			
Dieldrin	 	1	
Endosulfan I			<u> </u>
Endosulfan II			
Endosulfan sulfate			
Endrin			
Endrin aldehyde			<u> </u>
Lindane			
Heptachlor			
Heptachlor epoxide			
Methoxychlor			
Toxaphene			

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.8.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.8.4 shows the magnitude above the reference sediment sites for the miscellaneous inorganic parameter evaluation. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.8.4 Misc Parameter Evaluation

	LM-5	LM-5.5	LM-6	LM-6.5	LM-7
COD				1.01	1.24
Cyanide					
Ammonia		1			
Nitrite + Nitrate		1	4.00	1.75	2.00
TKN	1.51	1.48	1.05	1.43	1.98
Oil & Grease	1.45	1.33	1.51	1.05	
Total Phosphorus	1.27	1.47	1.42	1.20	1.32

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.8.5 Biological Evaluation

This channel reach consists of two sediment management units – [LM-5, LM-5.5, LM-6] (labeled as MA-7 in the chemistry reports and as B-7 in the biological reports) and [LM-6, LM-6.5, LM-7] (labeled as MA-8 in the chemistry reports and as B-8 in the biological reports). See Figure 2.3.

2.8.5.1 Water Column Elutriate Acute Toxicity Evaluation

The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were make to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect to the daphnia or minnows.

2.8.5.2 Sediment Solid Phase Toxicity Evaluation

The sediments for this channel reach were found to be similar in quality to the open-lake sediments.

2.8.5.3 Sediment Solid Phase Bioaccumulation

No measurable bioaccumulation of PAHs, pesticides, and PCBs was measured. Organic levels detected in the bioassay sediments had no effect.

Bioaccumulation of some metals did occur for the two sediment bioaccumulation management areas making up this channel reach. For the first sediment management area, the metals arsenic and mercury were found to bioaccumulate at levels statistically greater than the corresponding metals from the open-lake reference sediments. From the second area, chromium and lead bioaccumulated at levels that were statistically significantly different from the reference sediments.

The bioaccumulation levels for the metals may be artificially high because of the replicate average which used the high value for the non-detected values. This approach gave a conservative evaluation.

2.9 Lake Entrance Federal Navigation Channel Lake Mile 7 to Lake Mile 11 Evaluation This area consists of the federally maintained navigation channel from LM-7 to LM-11 and includes sampling sites LM-8, LM-9, LM-10, LM-11 (see Figure 2.9).

2.9.1 Metals Evaluation

Table 2.9.1 shows the magnitude above the sediment reference sites for areas LM-8, LM-9, LM-10 and LM-11. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.9.1 Metals Evaluation

	LM-8	LM-9	LM-10	LM-11
Antimony	2.00		2.00	2.00
Arsenic		1.62	2.41	2.62
Barium	1.77	1.53	1.60	1.47
Beryllium	2.00	1.75	2.00	1.50
Cadmium			1.13	1.20
Chromium	1.47	1.59	1.82	1.82
Cobalt	1.61	1.47	1.60	1.50
Copper	1.63	1.54	1.68	1.73
Lead	1.53	1.42	1.74	_1.63
Mercury	1.09	1.14	1.36	1.59
Nickel	1.53	1.47	1.63	1.63
Selenium				2.05
Silver	1.71	1.71	1.59	1.29
Thallium		1.50		
Vanadium	1.67	1.8	1.75	1.67
Zinc	1.54	1.41	1.67	1.54

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.9.2 PAH Evaluation

There is no exceedance for the PAH criteria as reflected below. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.9.2 PAH Evaluation

·	LM-8	LM-9	LM-10	LM-11
2-Methylnaphthalene	1			
Acenaphthene				
Acenaphthylene				
Anthracene				

Benzo(a)anthracene	
Benzo(a)pyrene	
Benzo(b)fluoranthene	
Benzo(ghi)perylene	
Benzo(k)fluoranthene	
Chrysene	
Dibenzo(a,h) anthracene	
Dibenzofuran	
Fluoranthene	
Fluorene	
Indeno(1,2,3-cd)pyrene	
Naphthalene	
Phenanthrene	
Pyrene	
Total PAH	

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.9.3 Pesticide & PCB Evaluation

Table 2.9.3 A shows the magnitudes above the sediment reference sites for PCBs in the areas where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.9.3 A PCB Evaluation

	LM-8	LM-9	LM-10	LM-11
Aroclor 1016				
Aroclor 1221	· ·			
Aroclor 1232				
Aroclor 1242				
Aroclor 1248				
Aroclor 1254				1.50
Aroclor 1260				

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of pesticide evaluation criteria. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.9.3 B Pesticide Evaluation

	LM-8	LM-9	LM-10	LM-11
4,4'-DDD				
4,4'-DDE				
4,4'-DDT				
Aldrin				
Alpha-BHC			 	
Beta- BHC				
Chlordane			 	

Delta-BHC	1	
Dieldrin		
Endosulfan I		
Endosulfan II		
Endosulfan sulfate		
Endrin		
Endrin aldehyde		
Lindane		
Heptachlor		
Heptachlor epoxide		
Methoxychlor	<u> </u>	
Toxaphene		

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.9.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.9.4 shows the magnitudes above the sediment reference sites for the miscellaneous inorganic parameters in the areas where exceedances occurred. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.9.4 Misc Parameter Evaluation

•	LM-8	LM-9	LM-10	LM-11
COD	1.52	1.42	1.22	1.56
Cyanide				
Ammonia				
Nitrite + Nitrate	2.00	1.25	1.25	5.00
TKN	1.83	1.37	1.33	1.68
Oil & Grease	1.33			1.74
Total Phosphorus	1.37	1.28	1.42	1.15

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.9.5 Biological Evaluation

The only sediments tested biologically for this channel section were the sediments at sampling site LM-10. See Figure 2.3. For biological testing this site is labeled B-9 in the biological reports and LM-10 in the chemistry reports.

2.9.5.1 Water Column Elutriate Acute Toxicity Evaluation

The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect to the daphnia or minnows.

2.9.5.2 Sediment Solid Phase Toxicity Evaluation

The sediments at RM-10 are compatible with the open-lake sediments with respect to toxicity but the *Chironomus tentans* growth is statistically significantly different.

2.9.5.3 Sediment Solid Phase Bioaccumulation

No measurable bioaccumulation of PAHs, pesticides, and PCBs was measured. Organic levels detected in the bioassay sediments had no effect.

This channel reach is represented by site LM-10. No metals were found to bioaccumulate at levels statistically greater than the corresponding metals from the open-lake reference sediments.

2.10 Lake Entrance Federal Navigation Channel Lake Mile 11 to Lake Mile 16 Evaluation This area consists of the federally maintained navigation channel from LM-11 to LM-16 and includes sampling sites LM-12, LM-13, LM-14, LM-15, LM-16 (see Figure 2.10)

2.10.1 Metals Evaluation

Table 2.10.1 shows the magnitude above the sediment reference sites for areas LM-12, LM-13, LM-14, LM-15 and LM-16. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.10.1 Metals Evaluation

	LM-12	LM-13	LM-14	LM-15	LM-16
Antimony	2.00	2.00	2.00		
Arsenic	2.38	2.10	2.10	1.30	1.45
Barium	1.57	1.23	1.23		
Beryllium	1.75	1.25	1.50		
Cadmium	1.27	1.13	1.33		
Chromium	2.06	1.71	1.88	1.06	1.71
Cobalt	1.61	1.34	1.39		1.16
Copper	1.86	1.45	1.59		1.27
Lead	1.74	1.47	1.68		1.58
Mercury	1.68	1.68	1.86	1.18	1.55
Nickel	1.84	1.47	1.58		1.32
Selenium					
Silver	1.43	1.29	1.29		1.29
Thallium	1.50	1.50			
Vanadium	1.83	1.50	1.50		1.25
Zinc	1.79	1.54	1.54		1.41

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.10.2 PAH Evaluation

There is no exceedance for the PAH criteria as illustrated below. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.10.2 PAH Evaluation

	LM-12	LM-13	LM-14	LM-15	LM-16
2-Methylnaphthalene					
Acenaphthene				1	
Acenaphthylene				T	
Anthracene	<u> </u>		·		
Benzo(a)anthracene				 	
Benzo(a)pyrene				·	
Benzo(b)fluoranthene					
Benzo(ghi)perylene			·		
Benzo(k)fluoranthene					
Chrysene					
Dibenzo(a,h) anthracene			······································	 	

Dibenzofuran			
Fluoranthene			· · · · · · · · · · · · · · · · · · ·
Fluorene			
Indeno(1,2,3-cd)pyrene			
Naphthalene			
Phenanthrene			
Pyrene			
Total PAH			

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.10.3 Pesticide & PCB Evaluation

Table 2.10.3 A shows the magnitude above the sediment reference sites for PCBs in areas LM-12, LM-13, LM-14, LM-15 and LM-16. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.10.3 A PCB Evaluation

	LM-12	LM-13	LM-14	LM-15	LM-16
Aroclor 1016		1			
Aroclor 1221					-
Aroclor 1232					
Aroclor 1242					
Aroclor 1248					
Aroclor 1254	1.33	1.33	1.17		1.17
Aroclor 1260					

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

There is no exceedance of pesticide evaluation criteria. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.10.3 B Pesticide Evaluation

	LM-12	LM-13	LM-14	LM-15	LM-16
4,4'-DDD					
4,4'-DDE					
4,4'-DDT					
Aldrin					
Alpha-BHC					
Beta- BHC					
Chlordane					

Delta-BHC	T T		
Dieldrin			1
Endosulfan I			
Endosulfan II			
Endosulfan sulfate			
Endrin			
Endrin aldehyde			
Lindane			
Heptachlor			<u> </u>
Heptachlor epoxide	·		
Methoxychlor		_	
Toxaphene			

NOTE – A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.10.4 Miscellaneous Inorganic Parameter Evaluation

Table 2.10.4 shows the magnitude above the sediment reference sites for the miscellaneous inorganic parameters in areas LM-12, LM-13, LM-14, LM-15 and LM-16. A blank shown for a cell indicates that the magnitude is less than one and the measured parameter level is equal to or less than the reference level.

Table 2.10.4 Misc Parameter Evaluation

	LM-12	LM-13	LM-14	LM-15	LM-16
COD	1.49	1.36	1.38		1.50
Cyanide					
Ammonia					
Nitrite + Nitrate	7.50	7.50	7.50	5.00	5.00
TKN					
Oil & Grease	2.23	2.43	2.57	1.11	2.29
Total Phosphorus	1.17	1.01			

NOTE - A blank cell indicates value less than reference For the data for developing this table, see Sec. 1.2

2.10.5 Biological Evaluation

The only sediments tested biologically for this channel section were the sediments at sampling site LM-13. See Figure 2.3. This site is labeled B-10 for the biological testing in the biological reports and LM-13 in the chemistry reports.

2.10.5.1 Water Column Elutriate Acute Toxicity Evaluation

The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect on the daphnia or minnows.

2.10.5.2 Sediment Solid Phase Toxicity Evaluation

The sediments at LM-13 were found to be compatible with the open-lake sediments.

2.10.5.3 Sediment Solid Phase Bioaccumulation

No measurable bioaccumulation of PAHs, pesticides, and PCBs was measured. Organic levels detected in the bioassay sediments had no effect.

Bioaccumulation of some metals did occur for site LM-13 that represents the management area for bioaccumulation testing for this channel reach. Cadmium was found to bioaccumulate at levels statistically

greater than the corresponding metal from the open-lake reference sediments. Although the level for this metal was statistically significantly different from the reference sediments, the actual levels were not that high above the reference levels.

The bioaccumulation levels for the metals may be artificially high because of the replicate average which used the high value for the non-detected values. This approach gave a conservative evaluation.

3.0 SEDIMENT ELUTRIATE WATER EVALUATION

The elutriate test provides information on what might be expected as to the degree chemical parameters could be dissolved into the water from the sediments during a disposal operation in the open-lake. This testing is very vigorous and the chemical concentrations found in the supernatant are considered very conservative.

3.1 Water Quality Evaluation Criteria

The water from the elutriate testing was evaluated against the State of Ohio EPA water quality standards for Lake Erie.

Below in Table 3.1 A are the 1997 water quality evaluation criteria extracted from Ohio EPA, Division of Surface Water, Ohio Administrative Code 3745-1, Water Quality Standards.

Table 3.1 A

	Aquatic Habitat Outside Mixing Zone		Human
			Health
	Maximum	30-d avg	30-d avg
Metals			
Arsenic - dissolved	340 ug/l	150 ug/l	
Arsenic – total	340 ug/l	150 ug/l	
Cadmium - dissolved	4.3 ug/l	2.2 ug/l	
Cadmium - total	4.5 ug/l	2.5 ug/l	
Chromium - dissolved	570 ug/l	74 ug/l	
Chromium - total	1800 ug/l	86 ug/l	
Copper - dissolved	13 ug/l	9 ug/l	
Copper - total	14 ug/l	9.3 ug/l	
Lead - dissolved	97 ug/l	5.1 ug/l	
Lead - total	120 ug/l	6.4 ug/l	
Mercury - dissolved	1.4 ug/l	0.77 ug/l	
Mercury - total	1.7 ug/l	0.91 ug/l	0.0031 ug/l
Nickel -dissolved	470 ug/l	52 ug/l	
Nickel - total	470 ug/l	52 ug/l	
Selenium - dissolved		4.6 ug/l	
Selenium - total		5 ug/l	
Zinc - dissolved	120 ug/l	120 ug/l	
Zinc - total	120 ug/l	120 ug/l	
Inorganics			
Cyanide	22 ug/l	5.2 ug/l	48 ug/l
Ammonia	5.6 mg/l	0.9 mg/l	70 ug/1
Dissolved Oxygen	>6 ppm	0.5 Hg/I	
PH PH	>6.5<9		
PCBs		**-	0.026 ug/l

		<u> </u>	
Pesticides			
DDT		0.001 ug/l	0.00015 ug/l
Chlordane			0.00025 ug/l
Dieldrin	0.24 ug/l	0.056 ug/l	0.0065 ng/l
Endrin	0.086 ug/l	0.036 ug/l	
Lindane	0.95 ug/l		0.50 ug/l

The values selected may be conservative. The metal values selected were the lowest and are for a water hardness of 100 mg/l as CaCO₃. The selected ammonia value corresponds to a water pH of 8 and a water temperature of 25° C, which is for an exceptional warm water habitat and a cold water habitat.

3.2 Maumee River Federal Navigation Channel Evaluation

This area consists of the federally maintained navigation channel from RM-7 to RM-1 and includes sampling sites RM-7, RM-6, RM-5, RM-4, RM-3, RM-2, RM-1 (see Figure 2.4).

3.2.1 Metals Evaluation

The elutriate levels are conservative and do not reflect a mixing zone. The copper elutriate varied from 15 to 32 ug/l as opposed to 14 ug/l and 28 ug/l total recoverable for inside and outside the mixing zone, respectively. The inside-mixing zone maximum is 27 ug/l for a water hardness of 100 mg/l. Any elutriate would be quickly diluted at the dumpsite. The lake water hardness varies from 120 to 160 mg/l. The maximum dissolved inside mixing zone standard varies from 32 to 42 ug/l for these lake water hardness valves. Therefore, copper is not considered a problem. The zinc elutriate is 1000 ug/l. The inside mixing zone maximum standard is 120 ug/l and the outside mixing zone maximum is 240 ug/l. Even with a water hardness adjustment there may be a water standard violation. Currently, this material is confined.

3.2.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards.

3.2.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards.

3.2.4 Miscellaneous Inorganic Parameter Evaluation

RM-1: Ammonia exceedance of the 5.6 mg/l outside the mixing zone.

This value is based on a temperature of 20°C and a pH of 8.0 for an exceptional warm water habitat and a cold water habit. The elutriate value of 11.6 mg/l was measured and is considered conservative and if recorded in the field would be at the disposal point in the lake. A dilution factor of 2 would bring this value within the standards outside the mixing zone. This dilution would occur instantaneously and immediately around the barge during the disposal operation well within a mixing zone. This material is confined.

3.2.5 Sediment Water Column Elutriate Acute Toxicity Evaluation

Biological testing was not conducted on the river area because this dredged material is confined.

3.3 Maumee River Mouth Area Federal Navigation Channel Evaluation

This area consists of the federally maintained navigation channel from RM-1 to LM-1 and includes sampling sites RM-0.5, LM-0, LM-0.5 (see Figure 2.5).

3.3.1 Metals Evaluation

The elutriate levels are conservative and do not reflect a mixing zone. The copper elutriate for RM-0.5 is 26 ug/l as opposed to 28 ug/l total recoverable for inside the mixing zone. The inside mixing zone maximum is 27 ug/l dissolved for a water hardness of 100 mg/l. Any elutriate would be quickly diluted at the dumpsite. Copper is not considered a problem.

3.3.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards.

3.3.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the pesticide and PCB evaluation.

3.3.4 Miscellaneous Inorganic Parameter Evaluation

RM-1: Ammonia exceedance of the 5.6 mg/l outside the mixing zone.

This value is based on a temperature of 20° C and a pH of 8.0 which is for an exceptional warm water habitat and a cold water habit. The elutriate value of 11.5 mg/l was measured and is considered conservative and if recorded in the field would be at the disposal point in the lake. A dilution factor of 2 would bring this value within the standards outside the mixing zone. This dilution would occur instantaneously and immediately around the barge during the disposal operation well within a mixing zone.

3.3.5 Sediment Water Column Elutriate Acute Toxicity Evaluation

Sediments for this area were tested using sediments from RM-1, RM-0.5, and LM-0 as a sediment management unit and sediments from LM-0, LM-0.5, and LM-1 as a sediment management unit. See Figure 2.3. These units are variably labeled as MA-1 or B-1 and MA-2 or B-2 in various reports and tables. The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water was not acutely toxic to the daphnia or minnows, subsequently a LC₅₀ could not be determined.

3.4 Lake Entrance Federal Navigation Channel Lake Mile 2 Inward to River Mouth Area Evaluation

This area consists of the federally maintained navigation channel from LM-1 to LM-2 and includes sampling sites LM-1, LM-1.5, LM-2 (see Figure 2.6)

3.4.1 Metals Evaluation

The elutriate levels are conservative and do not reflect a mixing zone. The copper elutriate is 46 ug/l to 32 ug/l as opposed to 32 ug/l and 37 ug/l dissolved for inside the mixing zone for water hardness values of 120 and 140 mg/l. It could be said that there may be a standard violation. Any elutriate would be quickly diluted at the dumpsite.

3.4.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the PAH evaluation.

3.4.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the pesticides and PCBs evaluation.

3.4.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the inorganic evaluation.

3.4.5 Sediment Water Column Elutriate Acute Toxicity Evaluation

Sediments for this area were tested using sediments from LM-1, LM-1.5, and LM-2 as a sediment management unit. See Figure 2.3. This unit is sometimes labeled as MA-3 or B-3 in various tables and reports. The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were make to determine the dilution needed for 50 per cent survival. The full strength elutriate water was not acutely toxic to the daphnia or minnows. Initial screening indicated toxicity, but subsequent testing could not determine a LC₅₀. The laboratory attributed this to possible ammonia toxicity.

3.5 Lake Entrance Federal Navigation Channel Lake Mile 2 to Lake Mile 5 Evaluation This area consists of the federally maintained navigation channel from LM-2 to LM-5 and includes sampling sites LM-2.5, LM-3, LM-3, LM-4, LM-4.5 (see Figure 2.7).

3.5.1 Metals Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for metals.

3.5.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for PAHs for the PAHs.

3.5.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the pesticides and PCBs.

3.5.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the miscellaneous inorganic parameters.

3.5.5 Sediment Water Column Elutriate Acute Toxicity Evaluation

This area is represented by three sediment management units - [LM-2, LM-2.5, LM-3], [LM-3, LM-3.5, LM-4], and [LM-4, LM-4.5, LM-5]. See Figure 2.3. The two end points LM-2 and LM-5 are evaluated chemically in other channel areas. These three units are variably labeled as MA-4 or B-4, MA-5 or B-5, and RM-6 or B-6, respectively. The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect to the daphnia or minnows.

3.6 Lake Entrance Federal Navigation Channel Lake Mile 5 to Lake Mile 7 Evaluation This area consists of the federally maintained navigation channel from LM-5 to LM-7 and includes sampling sites LM-5, LM-5.5, LM-6, LM-6.5, LM-7 (see Figure 2.8).

3.6.1 Metals Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the measured metals.

3.6.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the measured PAHs.

3.6.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for pesticides and PCBs.

3.6.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the measured miscellaneous inorganic parameters.

3.6.5 Water Column Elutriate Acute Toxicity Evaluation

This channel reach consists of two sediment management units – [LM-5, LM-5.5, LM-6] and [LM-6, LM-6.5, LM-7]. See Figure 2.3. These are labeled MA-7 or B-7 and MA-8 or B-8, respectively, in various reports and tables. The water column evaluation is based on elutriate water from the sediments using Daphnia magna and Pimephales promelas (minnows) as test organisms. Dilutions on the elutriate water were make to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect to the daphnia or minnows

3.7 Lake Entrance Federal Navigation Channel Lake Mile 7 to Lake Mile 11 Evaluation This area consists of the federally maintained navigation channel from LM-7 to LM-11 and includes sampling sites LM-8, LM-9, LM-10, LM-11 (see Figure 2.9).

3.7.1 Metals Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the measured metals.

3.7.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the measured PAHs.

3.7.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the pesticides and PCBs.

3.7.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the miscellaneous inorganic parameters.

3.7.5 Water Column Elutriate Acute Toxicity Evaluation

The only sediments tested biologically for this channel section were the sediments at sampling site LM-10. See Figure 2.3. For biological testing this site is labeled B-9. The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect to the daphnia or minnows

3.8 Lake Entrance Federal Navigation Channel Lake Mile 11 to Lake Mile 16 Evaluation This area consists of the federally maintained navigation channel from LM-11 to LM-16 and includes sampling sites LM-12, LM-13, LM-14, LM-15, LM-16 (see Figure 2.10)

3.8.1 Metals Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the metals..

3.8.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the PAHs.

3.8.3 Pesticide & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the pesticides and PCBs.

3.8.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the inorganic parameters.

3.8.5 Water Column Elutriate Acute Toxicity Evaluation

The only sediments tested biologically for this channel section were the sediments at sampling site LM-13. See Figure 2.3. This site is labeled B-10 for the biological testing. The water column evaluation is based on elutriate water from the sediments using *Daphnia magna* and *Pimephales promelas* (minnows) as test organisms. Dilutions on the elutriate water were made to determine the dilution needed for 50 per cent survival. The full strength elutriate water had no toxic effect on the daphnia or minnows

4.0 DISPOSAL AREA WATER EVALUATION

The Toledo Harbor open-lake dredged sediment disposal area is a square one mile on the side. The sampling area for measuring conformance to the state water quality standards is square with a 2000-foot side. The area within this square is the mixing zone.

4.1 Water Quality Standards Criteria

Extractions from the 1997 Ohio EPA Water Quality Standards that are used for the evaluation process are given in Section 3.1.

4.2 Sampling Event 1

Water for the disposal of sediment from LM-5 was sampled on June 11th. Water was sampled at the center of a 2000-foot square just before sediment disposal. This provides background conditions. After sediment disposal at the center of the square, water was sampled at depths of 5 and 18 feet at each of the corners at various times. The metal analyses were performed on unfiltered water samples (total recoverable metals).

4.2.1 Metals Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the metals.

4.2.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the PAHs.

4.2.3 Pesticides & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards the pesticides and PCBs.

4.2.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the measured miscellaneous inorganic parameters.

4.3 Sampling Event 2

Water at the disposal site for the disposal of sediment from LM-8 was sampled on July 6th. Water was sampled at the center of a 2000-foot square just before sediment disposal. This provides background conditions. After sediment disposal at the center of the square, water was sampled at depths of 5 and 18 feet at each of the corners at various times. After a couple of hours the sampling event had to be called off because of weather and water conditions. The metal analyses were performed on filtered water samples (dissolved metals).

4.3.1 Metals Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the metals.

4.3.2 PAH Evaluation

There is no exceedance of the Ohio EPA 1997 water quality standards for the PAHs

4.3.3 Pesticides & PCB Evaluation

There is no exceedance of the Ohio EPA 1997 water quality standards for pesticides and PBCs.

4.3.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the Ohio EPA 1997 water quality standards for the measured miscellaneous inorganic parameters.

4.4 Sampling Event 3

Sampling event 3 is a substitute for sampling event 2. Water for the disposal of sediment from LM-7.8 was sampled on July 12th. Water was sampled at the center of a 2000-foot square just before sediment disposal. This provides background conditions. After sediment disposal at the center of the square, water was sampled at depths of 5 and 18 feet at each of the corners at various times. The metal was performed on filtered water samples (dissolved metals).

4.4.1 Metals Evaluation

One value for copper (15 ug/l) exceeded the 1997 State of Ohio water quality standards as defined in the table in Section 3.1. The standard value of 13 ug/l is for a water hardness of 100 mg/l and is conservative and the lowest value on the Ohio EPA standard table. 15 ug/l corresponds to a water hardness value of 112 ug/l. The average water hardness for the western basin of Lake Erie is 120 to 180 mg/l. Based upon this information, this was not a violation of the Ohio EPA 1997 water quality standards. Also, there was no violation of the 1996 standards at a water hardness value of 100 mg/l.

4.4.2 PAH Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for PAHs.

4.4.3 Pesticides & PCB Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the pesticides and PCBs.

4.4.4 Miscellaneous Inorganic Parameter Evaluation

There is no exceedance of the State of Ohio 1997 water quality standards for the miscellaneous inorganic parameters.

5.0 Channel Side Sediment Evaluation.

Metals, PAHs, pesticides, and PCBs were measured at points 200 feet on each side of the navigational channel at LM-3, LM-5, LM-8, LM-10, and LM-15. See Figure 5.0. Right and left samples are the right bank and left bank samples to a viewer going out into the lake. This was done in order to get an indication of how the chemistry of the channel sediments varies from the sediments outside the dredged channel. There is a question regarding whether the sediments dredged from the outer lake channel are resuspended lake bottom sediments or river and harbor deposited sediments.

5.1 Channel Location LM-3

A comparison of the parameter concentrations for LM-3 with the right and left channel sides is presented in the Table 5.1 below. All concentrations are in mg/kg (ppm). Bolded values reflect concentrations above the reference criteria developed in Section 2.1.

Table 5.1

	LM-3R	LM-3	LM-3L
Metals			
Antimony	0.3	0.3	0.3
Arsenic	6.5	5.5	2.5
Barium	70	90	79
Beryllium	0.5	0.7	0.6
Cadmium	0.5	0.7	0.7
Chromium	12	16	15
Cobalt	8.1	9.5	7.9
Copper	25	30	25
Lead	35	15	14
Mercury	0.19	0.08	0.08
Nickel	19	24	20
Selenium	< 0.94	0.4	<1.2
Silver	0.6	0.7	0.7
Thallium	0.3	0.2	0.2
Vanadium	16	20	18
Zinc	89	87	80
			1
PAHs			
2-Methylnaphthalene	<0.86	<1.3	<1.2
Acenaphthene	<0.43	<0.66	<0.59
Acenaphthylene	<0.43	<0.66	<0.59
Anthracene	0.10	<0.53	<0.47
Benzo(a)anthracene	0.18	<0.66	0.17
Benzo(a)pyrene	0.30	<0.66	0.14
Benzo(b)fluoranthene	0.19	<0.66	0.25
Benzo(ghi)perylene	<0.52	<0.79	0.14
Benzo(k)fluoranthene	0.14	<0.93	0.17
Chrysene	0.22	<0.66	0.23
Dibenzo(a,h) anthracene	<0.43	<0.66	<0.59
Dibenzofuran	<0.43	<0.66	<0.59
Fluoranthene	0.33	0.10	0.32
Fluorene	<0.43	<0.66	<0.59
Indeno(1,2,3-cd)pyrene	0.11	<0.66	0.13
Naphthalene	<0.43	<0.66	<0.59
Phenanthrene	0.24	<0.53	0.17
Pyrene	0.32	<0.53	0.26
Total PAH	2.13	0.10	1.98
PCBs			
Aroclor 1016	<0.17	<0.26	<0.23
Aroclor 1221	<0.17	<0.26	<0.23
Aroclor 1232	<0.17	<0.26	<0.23
Aroclor 1242	<0.17	<0.26	<0.23
Aroclor 1248	<0.17	<0.26	<0.23
Aroclor 1254	0.02	0.04	0.05

Aroclor 1260	<0.17	<0.26	<0.23
Pesticides			
4,4'-DDD	<0.35	<0.53	<0.47
4,4'-DDE	<0.52	<0.79	<0.70
4,4'-DDT	<0.52	<0.79	<0.70
Aldrin	<0.35	<0.53	<0.47
Alpha-BHC	<0.35	<0.53	<0.47
Beta- BHC	<0.35	<0.53	<0.47
Chlordane	<1.7	<2.6	<2.3
Delta-BHC	<0.35	<0.53	<0.47
Dieldrin	<0.35	<0.53	<0.47
Endosulfan I	<0.52	<0.79	<0.70
Endosulfan II	<0.52	<0.79	<0.70
Endosulfan sulfate	<0.52	<0.79	<0.70
Endrin	<0.86	<1.3	<1.2
Endrin aldehyde	<0.86	<1.3	<1.2
Lindane	<0.35	<0.53	<0.47
Heptachlor	<0.52	<0.79	<0.70
Heptachlor epoxide	<0.52	<0.79	<0.70
Methoxychlor	<0.52	<0.79	<0.70
Toxaphene	<1.7	<2.6	<2.3
Inorganics			
COD	53100	75500	57800
Cyanide	0.52	0.59	10
Ammonia	32.8	146	61.9
Nitrite + Nitrate	<0.38	4.7	0.6
TKN	1430	2300	1860
Oil & Grease	509	665	321
Total Phosphorus	540	900	820

There is a distinct randomness for some metal concentrations for the channel and side sediments. Overall for the metal chemistry, the channel and side areas appear to be similar. The PAH chemistry shows the right and left side chemistry to be distinct from the channel chemistry. The PCB chemistry shows the left side and channel to be similar. No conclusion can be drawn for the pesticide data. The miscellaneous inorganic parameter data are also very random.

Some metal, PAH, and miscellaneous inorganic parameter values exceeded the reference criteria in Section 2.1. Most of the exceeded values for the channel sediments were also exceeded for channel side areas. Only three exceeded values for the channel sediments were not. The PAH levels for side areas exceeded the criteria while the channel sediments did not. Total PAHs for the sides were 2.13 and 1.98 compared to 0.10 ppm for the channel. The inorganics showed that channel and side areas exceeded three out of five channel parameters.

5.2 Channel Location LM-5

A comparison of the parameter concentrations for LM-5 with the right and left channel sides is presented in Table 5.2 below. All concentrations are in mg/kg (ppm). Bolded values reflect concentrations above the reference criteria developed in Section 2.1.

Table 5.2

	LM-5R	LM-5	LM-5L
Metals			
Antimony	0.1	0.3	0.1
Arsenic	2.0	3.9	3.6
Barium	65	86	3.6
Beryllium	0.3	0.6	0.3
Cadmium	0.4	0.8	0.5
Chromium	6.4	16	5.5

Cobalt	3.7	8.8	4.0
Copper	12	27	13
Lead	8	14	15
Mercury	0.04	0.10	0.11
Nickel	9.0	23	9.1
Selenium	<0.53	<1.4	<0.45
Silver	<0.53	0.7	0.3
Thallium	0.1	0.2	0.3
Vanadium	8.3	19	7.8
Zinc	40	86	46
Zilic	40	80	40
PAHs			
2-Methylnaphthalene	<0.96	<1.2	<0.69
Acenaphthene	<0.48	<0.62	<0.34
Acenaphthylene	<0.48	<0.62	<0.34
Anthracene	<0.38	<0.49	<0.28
Benzo(a)anthracene	<0.48	<0.62	<0.34
Benzo(a)pyrene	<0.48	<0.62	0.11
Benzo(b)fluoranthene	<0.48	<0.62	0.10
Benzo(ghi)perylene	<0.58	<0.74	<0.41
Benzo(k)fluoranthene	<0.67	<0.86	<0.48
Chrysene	<0.48	<0.62	0.11
Dibenzo(a,h) anthracene	<0.48	<0.62	<0.34
Dibenzofuran	<0.48	<0.62	<0.34
Fluoranthene	0.10	0.11	0.11
Fluorene	<0.48	<0.62	<0.34
Indeno(1,2,3-cd)pyrene	<0.48	<0.62	<0.34
Naphthalene	<0.48	<0.62	<0.34
Phenanthrene	<0.48	<0.49	<0.28
Pyrene	0.10	0.10	0.12
Total PAH	0.20	0.21	0.55
,			
PCBs			
Aroclor 1016	<0.19	<0.25	<0.14
Aroclor 1221	<0.19	<0.25	<0.14
Aroclor 1232	<0.19	<0.25	<0.14
Aroclor 1242	<0.19	<0.25	<0.14
Aroclor 1248	<0.19	<0.25	<0.14
Aroclor 1254	0.03	0.04	0.02
Aroclor 1260	<0.19	<0.25	<0.14
Docticidos			
Pesticides	0.22	-0.10	- 0.00
4,4'-DDD	<0.38	<0.49	<0.28
4,4'-DDE	<0.58	<0.74	<0.41
4,4'-DDT	<0.58	<0.74	<0.41
Aldrin	<0.38	<0.49	<0.28
Alpha-BHC	<0.38	<0.49	<0.28
Beta- BHC	<0.38	<0.49	<0.28
Chlordane	<1.9	<2.5	<1.4

Delta-BHC	<0.38	<0.49	<0.28
Dieldrin	<0.38	<0.49	
Endosulfan I	<0.58	+ 	<0.28
		<0.74	<0.41
Endosulfan II	<0.58	<0.74	<0.41
Endosulfan sulfate	<0.58	<0.74	<0.41
Endrin	<0.96	<1.2	<0.69
Endrin aldehyde	<0.96	<1.2	<0.69
Lindane	<0.38	<0.49	<0.28
Heptachlor	<0.58	<0.74	<0.41
Heptachlor epoxide	<0.58	<0.74	<0.41
Methoxychlor	<0.58	<0.74	<0.41
Toxaphene	<1.9	<2.5	<1.4
Inorganics			
COD	28000	44400	32500
Cyanide	0.45	0.55	0.23
Ammonia	401	128	13.5
Nitrite + Nitrate	<0.36	<0.47	<0.15
TKN	1210	2570	775
Oil & Grease	147	417	363
Total Phosphorus	510	760	430

Some of the metal concentrations between the channel and side sediments appear to be random in distribution. Excluding this randomness, the metal chemistry seems to be similar between the sides and distinct from the channel chemistry. The PAH chemistry shows the right side and channel to be similar and distinct from the left side chemistry. The PCB chemistry shows all three to be similar. No conclusion can be drawn for the pesticide data. The miscellaneous inorganic parameter data are very random.

For this site, there is very little in way reference exceedance criteria for any of the three sediments. The only side channel exceedance was for the left side sediments for arsenic and oil & grease.

5.3 Channel Location LM-8

A comparison of the parameter concentrations for LM-8 with the right and left channel sides is presented in Table 5.3 below. All concentrations are in mg/kg (ppm). Bolded values reflect concentrations above the reference criteria developed in Section 2.1.

Table 5.3

	LM-8R	LM-8	LM-8L
Metals			
Antimony	0.2	0.2	0.1
Arsenic	3.0	2.5	6.6
Barium	82	94	67
Beryllium	0.7	0.8	0.6
Cadmium	1.4	1,3	1.2
Chromium	21	25	17
Cobalt	8.8	10	8.4
Copper	31	36	28
Lead	23	29	24
Mercury	0.20	0.24	0.16
Nickel	25	29	22
Selenium	<0.95	<1.0	<0.54
Silver	1.0	1.2	0.8
Thallium	0.2	0.2	0.3
Vanadium	18	20	16
Zinc	100	120	86
PAHs	 		
2-Methylnaphthalene	<1.2	<1.2	<0.88
Acenaphthene	<0.60	<0.61	<0.44
Acenaphthylene	< 0.60	<0.61	<0.44

Total Phosphorus	750	820	600
Oil & Grease	300	382	277
TKN	2140	3110	1320
Nitrite + Nitrate	1.2	0.8	0.4
Ammonia	25.1	67.5	86.9
Cyanide	0.49	0.44	0.24
COD	40400	79200	51700
Inorganics			· · · · · · · · · · · · · · · · · · ·
		ļ	
Toxaphene	<2.4	<2.5	<1.8
Methoxychlor	<0.72	<0.74	<0.53
Heptachlor epoxide	<0.72	<0.74	<0.53
Heptachlor	<0.72	<0.74	<0.53
Lindane	<0.48	<0.49	<0.35
Endrin aldehyde	<1.2	<1.2	<0.88
Endrin	<1.2	<1.2	<0.88
Endosulfan sulfate	<0.72	<0.74	<0.53
Endosulfan II	<0.72	<0.74	<0.53
Endosulfan I	<0.72	<0.74	<0.53
<u>Dieldrin</u>	<0.48	<0.49	<0.35
Delta-BHC	<0.48	<0.49	<0.35
Chlordane	<2.4	<2.5	<1.8
Beta- BHC	<0.48	<0.49	<0.35
Alpha-BHC	<0.48	<0.49	<0.35
Aldrin	<0.48	<0.49	<0.35
4,4'-DDT	<0.72	<0.74	<0.53
4,4'-DDE	<0.72	<0.74	<0.53
4,4'-DDD	<0.48	<0.49	<0.35
Pesticides			
		ļ	
Arocior 1260	<0.24	<0.23	₹0.18
Aroclor 1254 Aroclor 1260	<0.24	<0.25	<0.18
Aroclor 1248 Aroclor 1254	<0.24 0.05	0.06	0.01
Aroclor 1242	<0.24	<0.25 <0.25	<0.18
Aroclor 1232	<0.24	<0.25	<0.18
Aroclor 1221	<0.24	<0.25	<0.18
Aroclor 1016	<0.24	<0.25	<0.18
		-0.25	-0.10
PCBs			
			
Total PAH	0.74	0.33	0.60
Pyrene	0.16	0.10	0.14
Phenanthrene	<0.48	<0.49	<0.35
Naphthalene	<0.60	<0.61	<0.44
Indeno(1,2,3-cd)pyrene	<0.60	<0.61	<0.44
Fluorene	<0.60	<0.61	<0.44
Fluoranthene	0.12	0.10	0.12
Dibenzofuran	<0.60	<0.61	<0.44
Dibenzo(a,h) anthracene	<0.60	<0.61	<0.44
Chrysene	0.11	<0.61	0.11
Benzo(k)fluoranthene	0.10	<0.86	<0.62
Benzo(ghi)perylene	<0.72	<0.74	<0.53
Benzo(a)pyrene Benzo(b)fluoranthene	0.12	0.13	0.11
Benzo(a)anthracene	0.12	<0.61	0.11
Anthracene Penac(a)anthracene	<0.48 <0.60	<0.49 <0.61	<0.35 <0.44
A 20	-0.40	10.40	-0.25

The metal concentrations tend to show a similarity between the sides and the channel chemistry with a tendency toward a deviation of the left side chemistry from the channel and right side. The PAH data show the side chemistry to be somewhat distinct from the channel chemistry. The PCB data show the right side and channel chemistry to be different from the left side chemistry. No conclusion can be drawn from the pesticide data. The inorganic chemistry shows randomness with a tendency of the channel chemistry being different from the side chemistry.

Some metal and miscellaneous inorganic parameter values exceeded the reference criteria in Section 2.1. The exceeded metal values for the channel sediments were also exceeded for channel side areas. All exceeded values are in the same order of magnitude. There was no exceedance for the PAH levels. The inorganics showed channel and side sediment exceedance for three out of five parameters exceeded in the channel.

5.4 Channel Location LM-10

A comparison of the parameter concentrations for LM-10 with the right and left channel sides is presented in Table 5.4 below. All concentrations are in mg/kg (ppm). Bolded values reflect concentrations above the reference criteria developed in Section 2.1.

Table 5.4

	LM-10R	LM-10	LM-10L
Metals			
Antimony	0.1	0.2	0.1
Arsenic	5.5	7.0	7.2
Barium	69	85	87
Beryllium	0.7	0.8	0.8
Cadmium	1.9	1.7	1.7
Chromium	30	31	32
Cobalt	8.9	9.9	9.7
Copper	36	37	39
Lead	33	33	35
Mercury	0.30	0.30	0.34
Nickel	32	31	32
Selenium	0.4	0.4	0.4
Silver	1.1	1.2	1.4
Thallium	0.3	0.3	0.3
Vanadium	17	21	19
Zinc	120	130	130
	120	100	150
PAHs			
2-Methylnaphthalene	<1.1	<1.4	<1.3
Acenaphthene	<0.55	<0.68	<0.66
Acenaphthylene	<0.55	<0.68	<0.66
Anthracene	<0.44	<0.54	<0.53
Benzo(a)anthracene	<0.55	<0.68	<0.66
Benzo(a)pyrene	0.10	<0.68	<0.66
Benzo(b)fluoranthene	0.13	0.10	<0.66
Benzo(ghi)perylene	<0.66	<0.82	<0.79
Benzo(k)fluoranthene	<0.77	<0.95	<0.93
Chrysene	0.11	<0.68	<0.66
Dibenzo(a,h) anthracene	<0.55	<0.68	<0.66
Dibenzofuran	<0.55	<0.68	<0.66
Fluoranthene	0.10	<0.68	<0.66
Fluorene	<0.55	<0.68	<0.66
Indeno(1,2,3-cd)pyrene	<0.55	<0.68	<0.66
Naphthalene	<0.55	<0.68	<0.66
Phenanthrene	<0.44	<0.68	<0.53
Pyrene	0.13	0.12	<0.53
Total PAH	0.57	0.22	0
PCBs			
Aroclor 1016	<0.22	<0.27	<0.26
Aroclor 1221	<0.22	<0.27	<0.26
Aroclor 1232	<0.22	<0.27	<0.26
Aroclor 1242	<0.22	<0.27	<0.26
Aroclor 1248	<0.22	<0.27	<0.26
Aroclor 1254	0.07	0.06	0.09
Aroclor 1260	<0.22	<0.27	<0.26

		I	
Pesticides			
4,4'-DDD	<0.44	<0.54	<0.53
4,4'-DDE	< 0.66	< 0.82	<0.79
4,4'-DDT	<0.66	<0.82	<0.79
Aldrin	<0.44	<0.54	<0.53
Alpha-BHC	<0.44	<0.54	<0.53
Beta- BHC	<0.44	<0.54	<0.53
Chlordane	<2.2	<2.7	<2.6
Delta-BHC	<0.44	<0.54	<0.53
Dieldrin	<0.44	<0.54	< 0.53
Endosulfan I	<0.66	<0.82	<0.79
Endosulfan II	<0.66	<0.82	<0.79
Endosulfan sulfate	<0.66	<0.82	<0.79
Endrin	<1.1	<1.4_	<1.3
Endrin aldehyde	<1.1	<1.4	<1.3
Lindane	<0.44	<0.54	<0.53
Heptachlor	<0.66	<0.82	<0.79
Heptachlor epoxide	<0.66	<0.82	<0.79
Methoxychlor	<0.66	<0.82	<0.79
Toxaphene	<2.2	<2.7	<2.6
Inorganics			
COD	48700	63300	71400
Cyanide	0.33	0.39	0.40
Ammonia	12.2	32.6	18.5
Nitrite + Nitrate	1.0	0.5	2.5
TKN	2290	2260	3880
Oil & Grease	344	161	358
Total Phosphorus	760	850	850

The metals data show strong similarities that the channel and side sediment chemistry is very similar. The PAH data are random and show no distinct correlation. The PCB data show the sediments to be similar. No inferences can be made from the pesticide data. The inorganic parameter data are also very random.

Some metal and miscellaneous inorganic parameter values exceeded the reference criteria in Section 2.1. The exceeded metal values for the channel sediments were also exceeded for channel side areas. All exceeded values for each metal are similar. There was no exceedance for the PAH levels. The inorganics showed channel and side sediment exceedance for three parameters and side area exceedance excluding the channel for two other parameters.

5.5 LM-15

A comparison of the parameter concentrations for LM-15 with the right and left channel sides is presented in Table 5.5 below. All concentrations are in mg/kg (ppm). Bolded values reflect concentrations above the reference criteria developed in Section 2.1.

Table 5.5

	LM-15R	LM-15	LM-15L
Metals			
Antimony	0.1	0.1	0.1
Arsenic	2.6	3.8	3.6
Barium	24	33	34
Beryllium	0.2	0.3	0.4
Cadmium	1.2	1.0	1.4
Chromium	16	18	23
Cobalt	4.2	5.4	5.5
Copper	17	20	22
Lead	16	18	23
Mercury	0.25	0.26	0.26

Nickel	15	17	20
Selenium	<0.47	<0.52	20 <0.73
Silver	0.4	0.5	0.6
Thallium	0.2	0.1	0.2
Vanadium	8.5	11	11
Zinc	67	76	88
PAHs			
2-Methylnaphthalene	<0.78	<0.89	
Acenaphthene	<0.78	<0.45	<0.90 <0.45
Acenaphthylene	<0.39	<0.45	<0.45
Anthracene	<0.31	<0.36	<0.36
Benzo(a)anthracene	<0.39	<0.45	<0.45
Benzo(a)pyrene	<0.39	<0.45	<0.45
Benzo(b)fluoranthene	<0.39	<0.45	<0.45
Benzo(ghi)perylene	<0.47	<0.53	<0.54
Benzo(k)fluoranthene	<0.55	<0.62	< 0.63
Chrysene	<0.39	<0.45	<0.45
Dibenzo(a,h) anthracene	<0.39	<0.45	<0.45
Dibenzofuran	<0.39	<0.45	<0.45
Fluoranthene Fluorene	0.13 <0.39	<0.45	<0.45
Indeno(1,2,3-cd)pyrene	<0.39	<0.45 <0.45	<0.45
Naphthalene	<0.39	<0.45	<0.45
Phenanthrene	<0.39	<0.45	<0.45 <0.36
Pyrene	0.13	<0.36	<0.36
Total PAH	0.26	0	0.30
			
PCBs		 	
Aroclor 1016	-016	-010	
Aroclor 1010	<0.16 <0.16	<0.18	<0.18
Aroclor 1232	<0.16	<0.18	<0.18 <0.18
Aroclor 1242	<0.16	<0.18	<0.18
Aroclor 1248	<0.16	<0.18	<0.18
Aroclor 1254	0.06	0.05	0.07
Aroclor 1260	<0.16	<0.18	<0.18
Pesticides			
4,4'-DDD	-0.21	0.26	
4,4'-DDE	<0.31 <0.47	<0.36 <0.53	<0.36
4,4'-DDT	<0.47	<0.53	<0.54
Aldrin	<0.31	<0.36	<0.54 <0.36
Alpha-BHC	<0.31	<0.36	<0.36
Beta- BHC	<0.31	<0.36	<0.36
Chlordane	<1.6	<1.8	<1.8
Delta-BHC	<0.31	<0.36	<0.36
Dieldrin	< 0.31	<0.36	<0.36
Endosulfan I	<0.47	<0.53	<0.54
Endosulfan II	<0.47	<0.53	<0.54
Endosulfan sulfate Endrin	<0.47	<0.53	<0.54
Endrin aldehyde	<0.78	<0.89	<0.90
Lindane Lindane	<0.78 <0.31	<0.89	<0.90
Heptachlor	<0.47	<0.36 <0.53	<0.36 <0.54
Heptachlor epoxide	<0.47	<0.53	<0.54
Methoxychlor	<0.47	<0.53	<0.54
Toxaphene	<1.6	<18	<1.8
			12.5
Inorganies			
Inorganics	20000	6655	
Cyanida	28600	38200	33900
Cyanide Ammonia	<0.27	0.20	<0.35
Nitrite + Nitrate	11	14	25
TKN	965	630	2
	703	030	1420

Oil & Grease	330	321	359
Total Phosphorus	430	453	460

The metals data show that the channel and side sediment chemistry are very similar. The PAH data indicate that the right side sediments may be different from the channel and left side sediments. The PCB data show all the sediments to be similar. No inferences can be made from the pesticide data. The inorganic parameter data appear to be random and tend to show similarities among the three sediment reaches.

For this site, only one channel and two left side areas show that the nitrite and nitrate concentrations exceed the reference criteria for all three-sediment samples.

6.0 SUMMARY

Table 6.0 shows the general trend of contamination for the combined analytes at each of the study reaches. If there is an exceedance for any parameter for any of the sites in an area, then the area is marked with an "X".

Table 6.0 Summary of all Analytes at all Reaches

	RM-7 to RM-1	RM-1 to LM-1	LM-1 to LM-2	LM-2 to LM-5	LM -5 to LM-7	LM-7 to LM-11	LM-11 to LM-16
Sediment Metals	X	X	X	X	X	X	X
Sediment PAHs	X	X	X	X	X		
Sediment Pesticides							
Sediment PCBs	X	X				X	X
Sediment Inorganics	X	X	X	X	X	X	X
Elutriate Metals		X ¹					
Elutriate PAHs							
Elutriate Pesticides				· · · · · · · · · · · · · · · · · · ·			
Elutriate PCBs							
Elutriate Inorganics							
Water Metals	*						
Water PAHs	*						
Water Pesticides	*						
Water PCBs	*						
Water Inorganics	*						
D. magna Elutriate	*		<u> </u>	<u> </u>			
P. promelas Elutriate	*						
H. azteca Toxicity	*		X^2			,	
C. tentans Toxicity	*						
C. tentans Growth	*	X ³				\mathbf{X}^4	
L. variegatus Metals	*	X	X	X	X		X
L. variegatus PAHs	*						
L. variegatus Pesticides	*						
L. variegatus PCBs	*			l —			

X indicates exceedance of criteria

* indicates no testing in this area

1 possible zinc water quality standard problem

possible toxicity to Ammonia

³ reduced growth at river mouth

4 site LM-10 only reduced growth

According to the sediment evaluation criteria and protocols provided in the Great Lakes Dredged Material Testing and Evaluation Manual, 1997 and the Evaluation of Dredged Material Proposed for Discharge in Water of the U.S. – Testing Manual (Inland Testing Manual) for the placement of dredged materials in open waters, the biological testing takes precedence over the chemistry evaluation. Elevated chemical data results that are elevated relative to the reference site do not necessarily mean there is a problem. If chemistry levels are found above the comparison reference sediments and biological testing for toxicity and bioaccumulation show that the disposal sediments are statistically similar to the sediments in the area of disposal, the chemistry evaluation is superseded and the sediments are suitable for open water disposal.

6.1 Channel Area from RM-7 to RM-1

Because no sediment management units were used for biological testing for this reach, evaluation criteria fall back to the sediment chemistry evaluation. It appears that there would be no exceedances of the Ohio EPA water quality standards for the sediment elutriate. Based on the sediment criteria, there are problems with some metal concentrations, PAH levels, and oil and grease concentrations. The main problems with the metals are for arsenic and barium with scattered zinc, nickel, and copper exceedances. Two sites had total PAH concentrations of just over 1 ppm. In the past, dredged material from this whole river reach was disposed in the Toledo CDF.

6.2 Channel Area from RM-1 to LM-1

Sediments from this reach generally have elevated levels of arsenic and barium. The RM-0.5 site sediments have high levels of copper, lead, mercury, selenium, zinc, nitrogen species, oil and grease, phosphorus, and PAH (3.66 ppm) levels. This area is in the vicinity of the Toledo sewage treatment plant outfall. The sediment elutriate showed the zinc elutriate could possibly contravene the Ohio EPA water quality standards. Sediments from this reach are covered by two sediment management units ([RM-1, RM-0.5, LM-0] and [LM-0, RM-0.5, LM-1]). The water quality standards and biological testing take precedent over the sediment chemistry.

6.3 Channel Area from LM-1 to LM-2

This reach has problems with arsenic, barium, and nitrogen species levels with LM-2 having nickel, zinc, and copper exceedances. The sediment management unit *Hyalella azteca* toxicity was found to be statistically significantly different from the open-lake reference sediments. These sediments are not suitable for open-lake disposal based upon the criteria in the Great Lakes Testing Manual. The testing laboratory attributes this to the possibility of ammonia poisoning. The sediment management unit *Chironomus tentans* toxicity and growth was found to be similar to that of the open-lake sediments. Because the bioassay would take precedence over the sediment chemistry analysis and if the toxicity is not due to ammonia, these sediments would be classified as different from the lake sediments. Traditionally, these sediments are considered the most polluted (possible settling from the Maumee River) and are disposed of in the Toledo CDF.

6.4 Channel Area from LM-2 to LM-5

This reach has chemistry problems with arsenic, barium, copper, and nitrogen species levels with sporadic problems with nickel, selenium, and mercury exceedances. This reach is represented by three sediment management units: [LM-2, LM-2.5, LM-3]; [LM-3, LM-3.5, LM-4]; and [LM-4, LM-4.5, LM-5]. These sediments showed no adverse effects to the elutriate dilutions and toxicity testing. The water quality standards and biological testing take precedence over the sediment chemistry. These sediments have recently been disposed into the CDF.

6.5 Channel Area from LM-5 to LM-7

This reach has chemistry problems with barium, copper, and nitrogen species levels with sporadic exceedances of with nickel, selenium, and zinc. This reach is represented by two sediment management

units: [LM-5, LM-5.5, LM-6] and [LM-6, LM-6.5, LM-7]. These sediments showed no adverse effects to the elutriate dilutions and toxicity testing. The water quality standards and biological testing take precedence over the sediment chemistry. These sediments have recently been subjected to open-lake disposal. The sediments for this reach were found to be compatible with the open-lake sediments.

6.6 Channel Area from LM-7 to LM-11

This reach has chemistry problems with arsenic, barium, chromium, copper, lead, nickel, zinc, and nitrogen species levels with sporadic problems with mercury and selenium exceedances. This reach is represented by LM-7, which is part of sediment management unit [LM-6, LM-6.5, LM-7 and LM-10 as a separate sediment management site. Sediments at these two locations have no adverse effects to the elutriate dilutions and toxicity testing. However, the tested sediments at sample site LM-10, had significantly lower growth for the test organism *Chironomus tentans*. The Ohio EPA water quality standards were not contravened by sediments from this location. The water quality standards and biological testing override the sediment chemistry. These sediments have routinely been subjected to open-lake disposal.

6.7 Channel Area from LM-11 to LM-16

Sediments from this reach have been sporadically dredged and disposed of at the open-lake disposal area. This reach has chemistry problems with arsenic, barium, cadmium, chromium, lead, mercury, nickel, zinc, and nitrogen species levels. This reach is represented by LM-13 as a separate sediment management site. Sediments from this location have no adverse effects to the elutriate dilutions and toxicity testing. The Ohio EPA water quality standards were not contravened by sediments from this location. The water quality standards and biological testing override the sediment chemistry.

6.8 Overall Summary

For the table below, if biological and water quality data are available, then these data supersede the chemistry data (chemistry not shown), otherwise, the chemical data are to be considered in the evaluation.

	RM-7 to	RM-1 to	LM-1 to	LM-2 to	LM -5 to	LM-7 to	LM-11 to
	RM-1	LM-1	LM-2	LM-5	LM-7	LM-11	LM-16
Sediment Evaluation	C	$G^{1}M$	T^2M	M	M	\mathbf{G}^3	M

C - Chemistry criteria problems, no biological testing

T – Biological toxicity criteria problems

G – Biological growth criteria problems

M – Possible metals bioaccumulation problems

1 - Chironomus tentans growth reduction at river mouth

² – Possible ammonia toxicity

³ – Chironomus tentans growth reduction at LM-10

Below is an overall summary of the bioaccumulation metals exceedance.

	RM-1 to LM-1	LM-1 to LM-2	LM-2 to LM-5	LM -5 to LM-7	LM-7 to LM-11	LM-11 to LM-16
Antimony						
Arsenic	X	X	X	X		
Barium	X					
Cadmium						X
Chromium	X	X		X		,
Copper	X					
Lead		X	X	X		
Mercury		X	X	X		
Nickel						
Zinc						

The bioaccumulation studies using Lumbriculus variegatus only address the uptake of the sediment contaminants to the worms. Uptake through the food chain up through the fish, birds, and wildlife that feed on the lower organisms is not addressed. Such studies are important in defining the allowable and suitable sediment contaminant concentrations. If the sediment concentrations are equal or lower the western basin levels, the water disposal should not effect the environment. Future studies may be needed along these lines.

		I
		•
		1
		•
		ì
		-
		•
		1
		1

TABLE 1.3 Latitude and longitude coordinates of sediment sampling sites for Toledo Harbor.

Harbor Feature	Sediment Sampling Site	Latitude	Longitude
Maumee River Channel	RM-0.5	41°41.50000′	83°28.72500'
	RM-1	41° 41.18333'	83° 28.63333'
	RM-2	41° 40.55000'	83° 29.31667'
	RM-3	41° 39.95000'	83° 30.16667'
	RM-4	41° 39.46667'	83° 31.13333'
	RM-5	41° 38.85000'	83° 31.90000'
	RM-6	41° 37.98333'	83° 31.85000'
	RM-7	41° 37.40000'	83° 32.43333'
Lake Entrance Channel	LM-0	41° 41.81667'	83° 27.81667'
	LM-0.5	41°42.05000'	83° 27.32500'
	LM-1	41° 42.28333'	83° 26.83333'
	LM-1.5	41° 42.51666'	83° 26.34166'
	LM-2	41° 42.75000'	83° 25.85000'
	LM-2.5	41°42.96667'	83° 25.35834'
	LM-3	41° 43.21667'	83° 24.86667'
Right Side of Channel	LM-3R	41° 43.13833'	83° 24.83333'
Left Side of Channel	LM-3L	41° 43.28333°	. 83° 24.95000°
Lake Entrance Channel	LM-3.5	41° 43.44167'	83° 24.37500'
	LM-4	41° 43.66667'	83° 23.88333'
•	LM-4.5	41° 43.90000'	83° 23.39166'
	LM-5	41° 44.13333'	·83° 22.90000'

		1
		1
		1
		1
		1
		1
		1
		1
		i
		•

TABLE 1.3 (Cont'd).

Harbor Feature	Sediment Sampling Site	Latitude	Longitude
Right Side of Channel	LM-5R	41° 44.06667'	83° 22.85000'
Left Side of Channel	LM-5L	41° 44.19167'	83° 23.16667'
Lake Entrance Channel	LM-5.5	41° 44.36666'	83° 22.40834'
	LM-6	41° 44.60000°	83° 21.91667'
	LM-6.5	41° 44.83334'	83° 21.42500'
	LM-7	41° 45.06667°	.83° 20.93333'
	LM-8	41° 45.50000°	83° 20.06667'
Right Side of Channel	LM-8R	41° 45.40833'	83° 20.01667'
Left Side of Channel	LM-8L	41° 45.55000'	83° 20.11667'
Lake Entrance Channel	LM-9	41° 46.00000°	83° 18.96667'
•	LM-10	41° 46.41667'	83° 18.05000'
Right Side of Channel	LM-10R	41° 46.36667'	83° 18.00000'
Left Side of Channel	LM-10L	41° 46.50000'	83° 18.13333'
Lake Entrance Channel	LM-11	41° 46.91667'	83° 17.00000'
	LM-12	41° 47.38333'	·83° 16.01667'
	LM-13	41° 47.85000°	83° 15.03333'
	LM-14	41° 48.31667'	83° 14.05000'
	LM-15	41° 48.78333'	83° 13.06667'
Right Side of Channel	LM-15R	41° 48.71667'	83° 13.03333'
Left Side of Channel	LM-15L	41° 48.85000°	83° 13.15000'
	LM-16	41° 49.25000'	83° 12.08333'

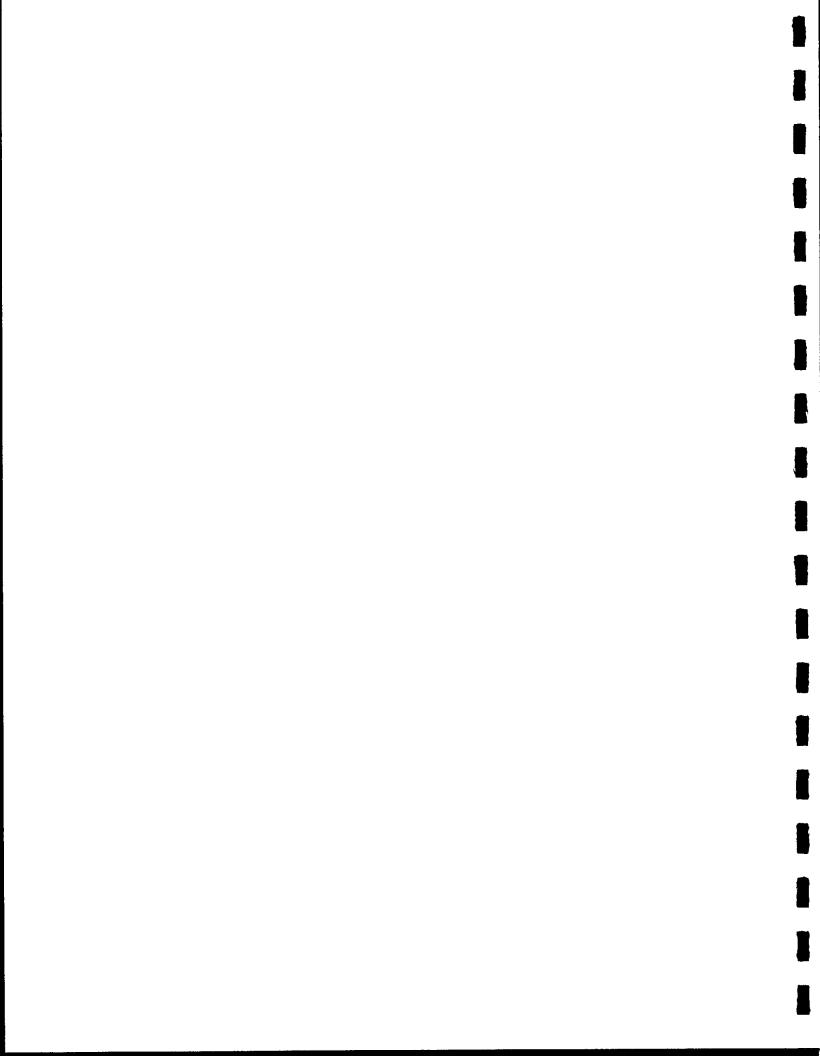
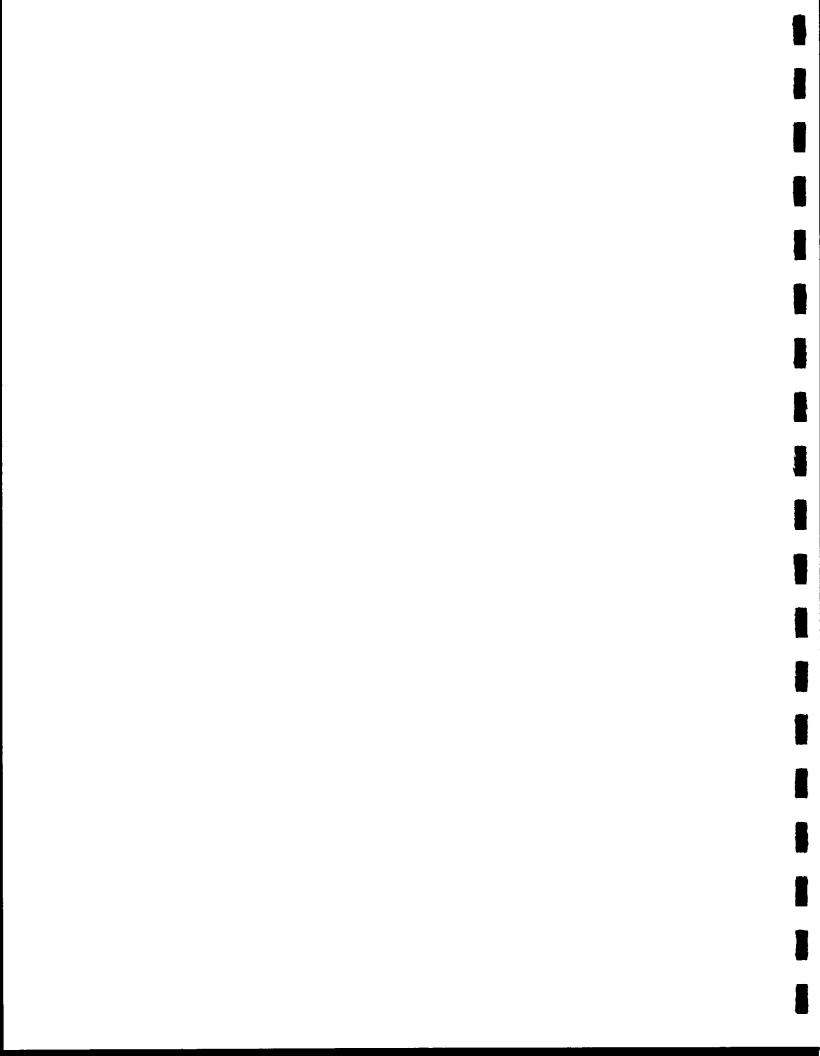


TABLE 1.3 (Cont'd).

Harbor Feature	Sediment Sampling Site	Latitude	Longitude
Disposal Area	D-1	41° 48.57500'	83° 17.40000'
•	D-2	41° 48.71667'	83° 16.60000'
	D-3	41° 48.21667'	83° 17.10000'
Reference Area	LR-1	41° 45.00000'	83° 16.71667'
	LR-2	41° 44.61667'	83° 16.00000'
	LR-3	41° 44.31667'	83° 16.60825'



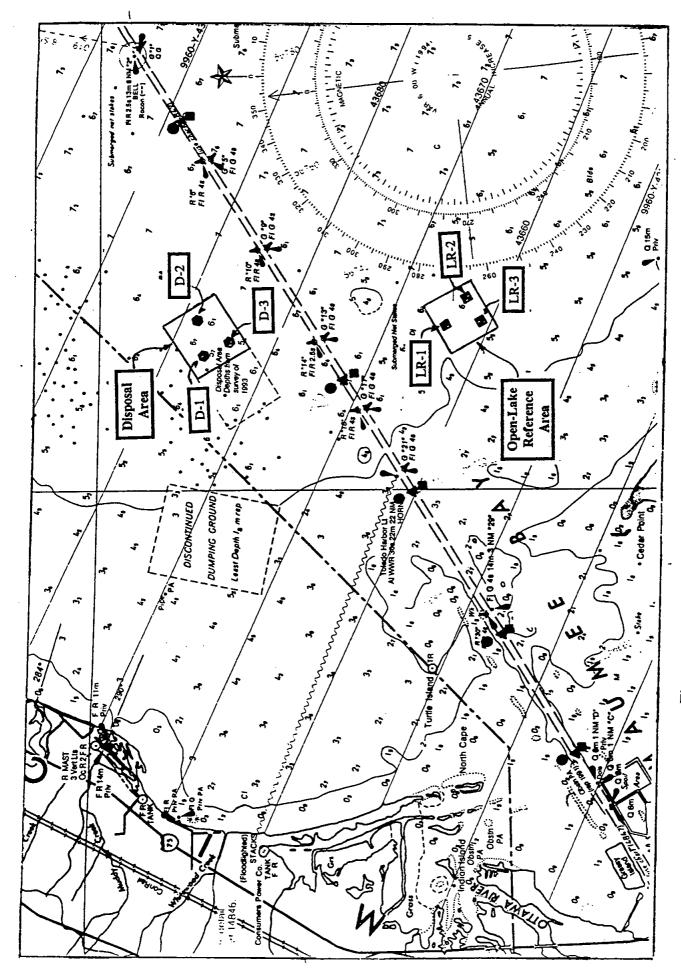


Figure 2.1 Toledo Harbor Open-Lake Reference Area and Sampling Sites.

4
8
•
•
1
•
3
-
•
•
•
I
1
_

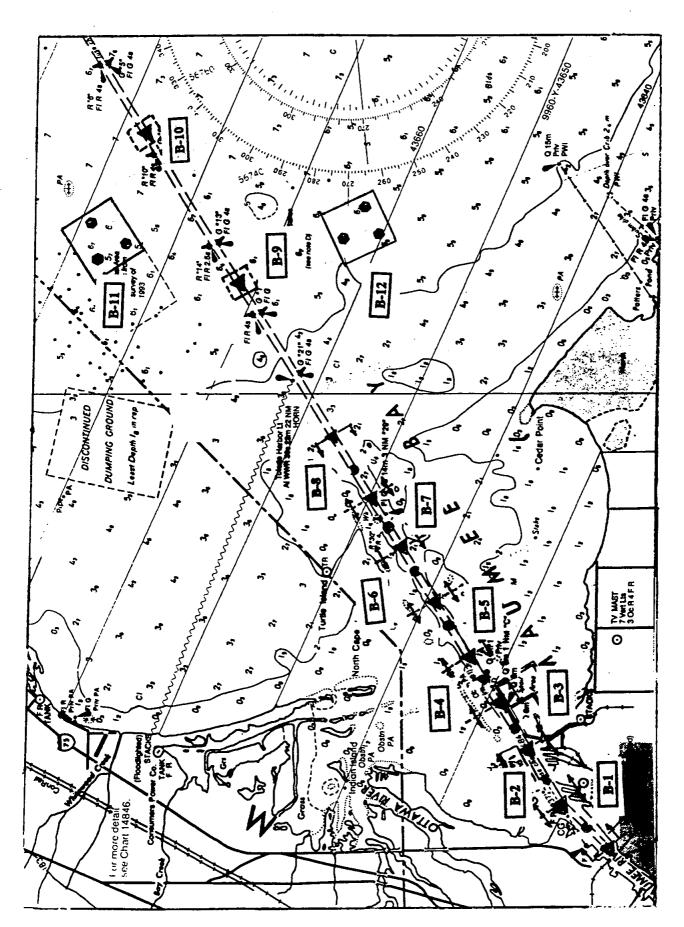


Figure 2.3 - Toledo Harbor - Biological Testing Areas.

		•
		i
		•
		ı
		1
		1
		ı
		•
		1
		1

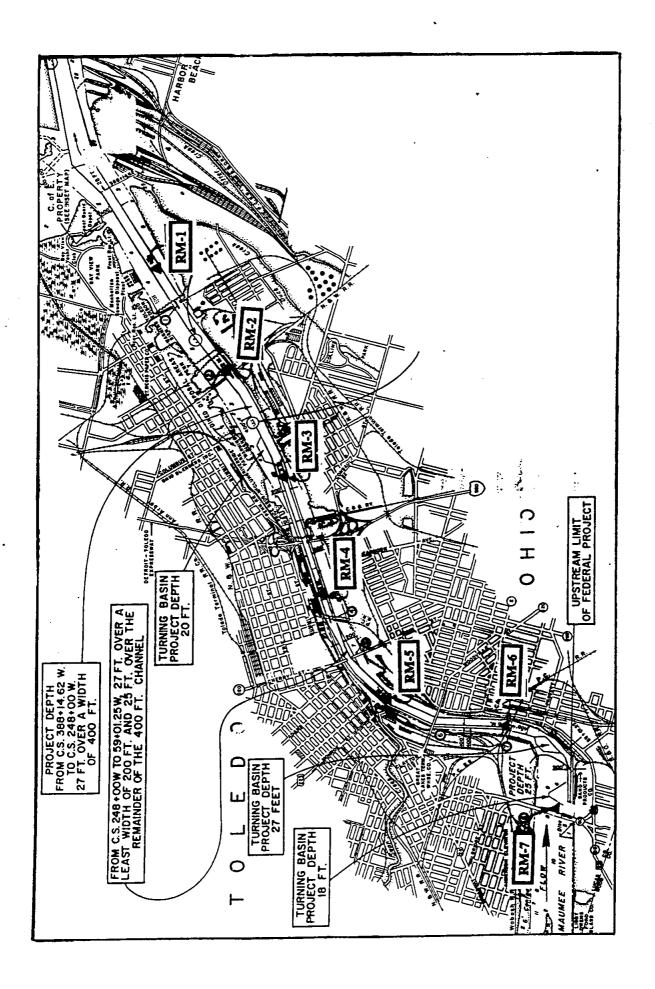
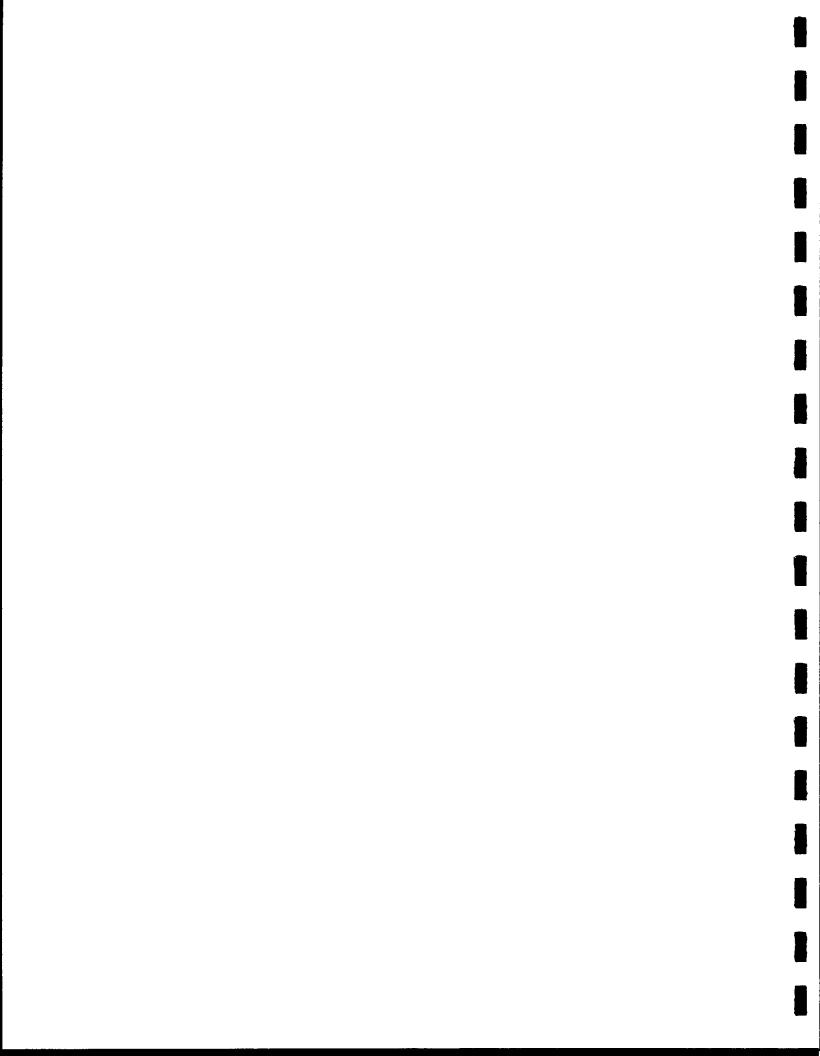


Figure 2.4 Toledo Harbor Federal Navigation Channel from RM-7 to RM-1.



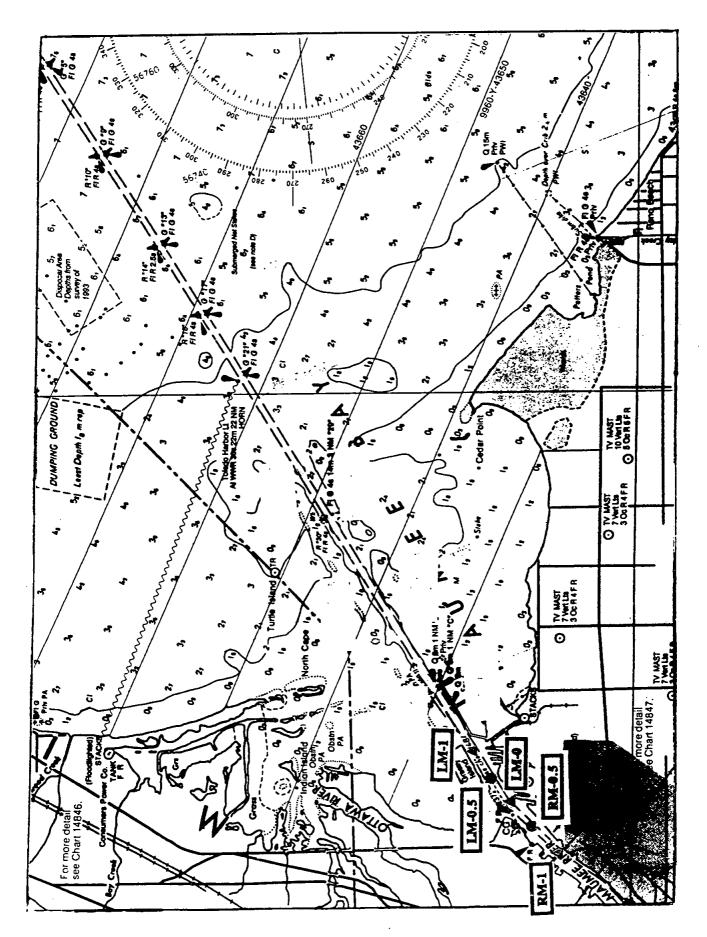
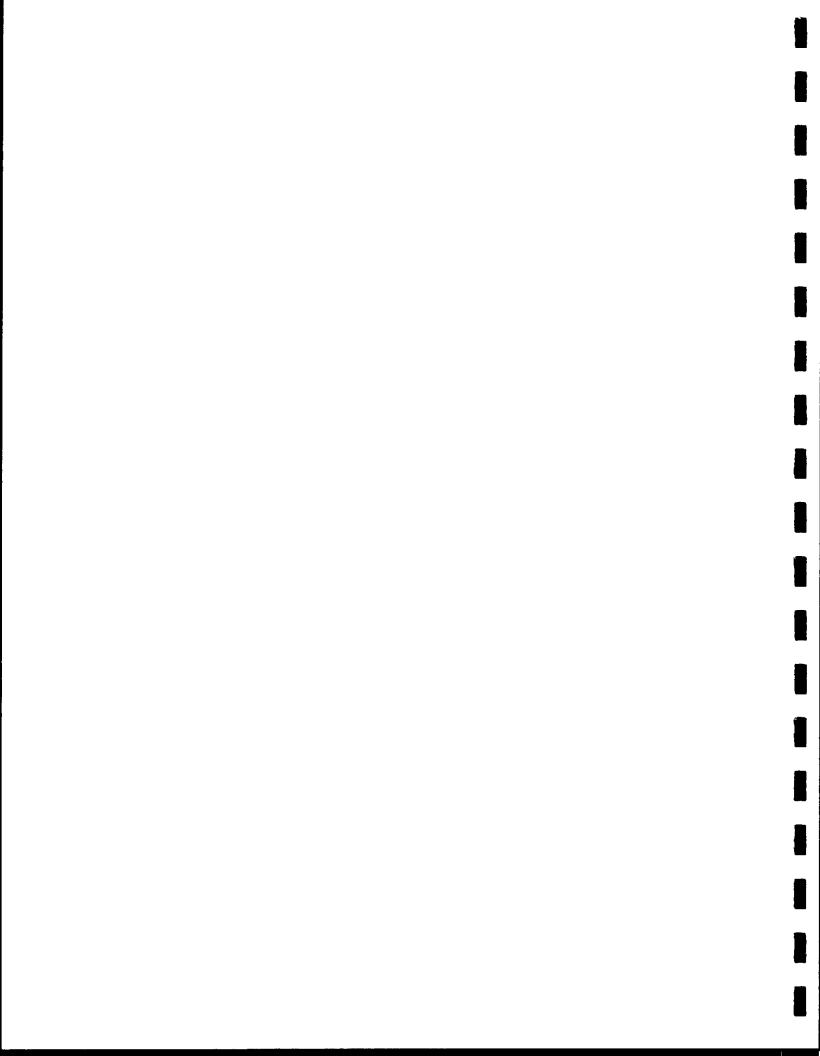


Figure 2.5 Toledo Harbor Federal Navigation Channel from RM-1 to LM-1.



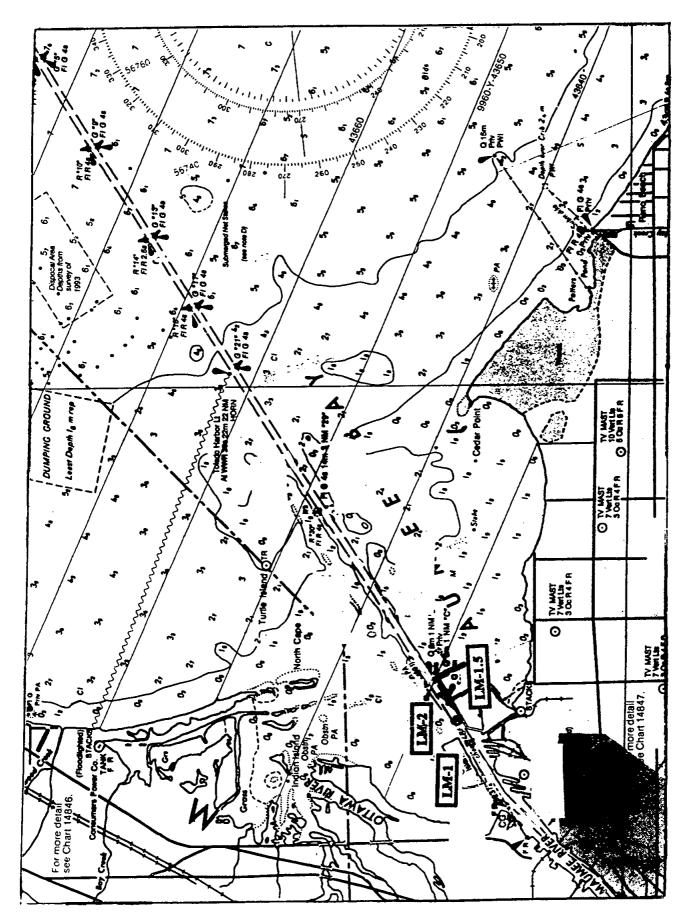


Figure 2.6 Toledo Harbor Federal Navigation Channel from LM-1 to LM-2.

	-
	-
	-
	-
	•
	•
	.

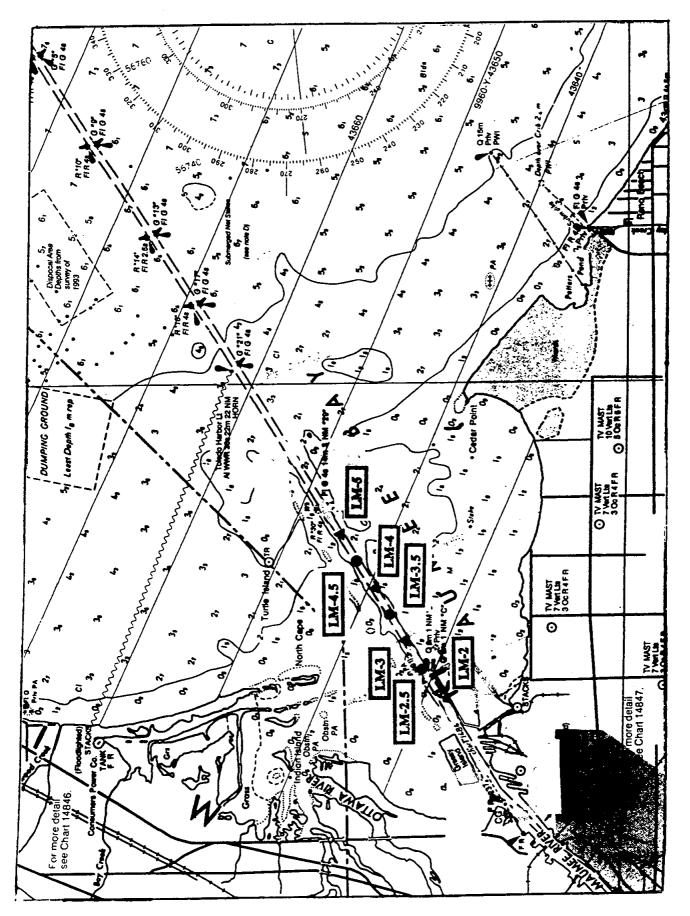


Figure 2.7 Toledo Harbor Federal Navigation Channel from LM-2 to LM-5.

		1
		1
		1
		1
		•
		1

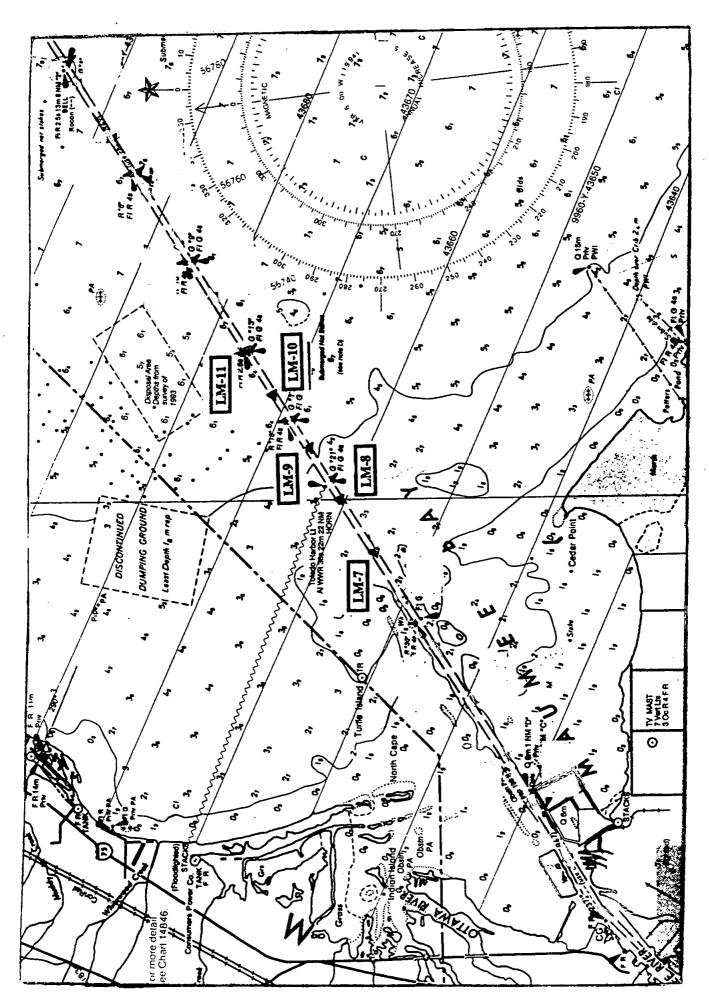


Figure 2.9 Toledo Harbor Federal Navigation Channel from LM-7 to LM-11.

	.
	1
	•

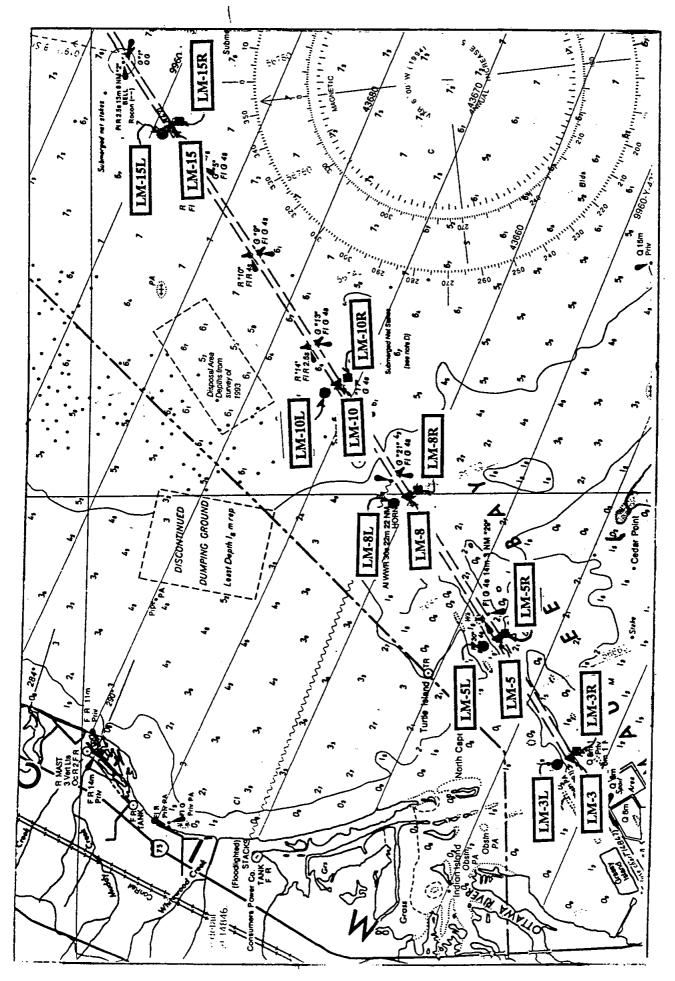


Figure 5.0 - Toledo Harbor Lake Entrance Channel Side Sampling Sites.

	1
	ı
	1
	•
	•
	1
	1
	ı
	•
	1
	1
	1
	1
	1
	1
	i
	1